The Journal of HEREDITY

A TWO-FACED KITTEN

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The "Sterilization Spectre"

A Livestock Scaling Instrument

Eyeless Pigs

Variability of Race Hybrids

Heredity and Mental Hygiene

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The

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The cattle of Africa, especially of South Africa have certain characteristics of considerable economic importance. They have also a long and interesting history which will be outlined in this article.

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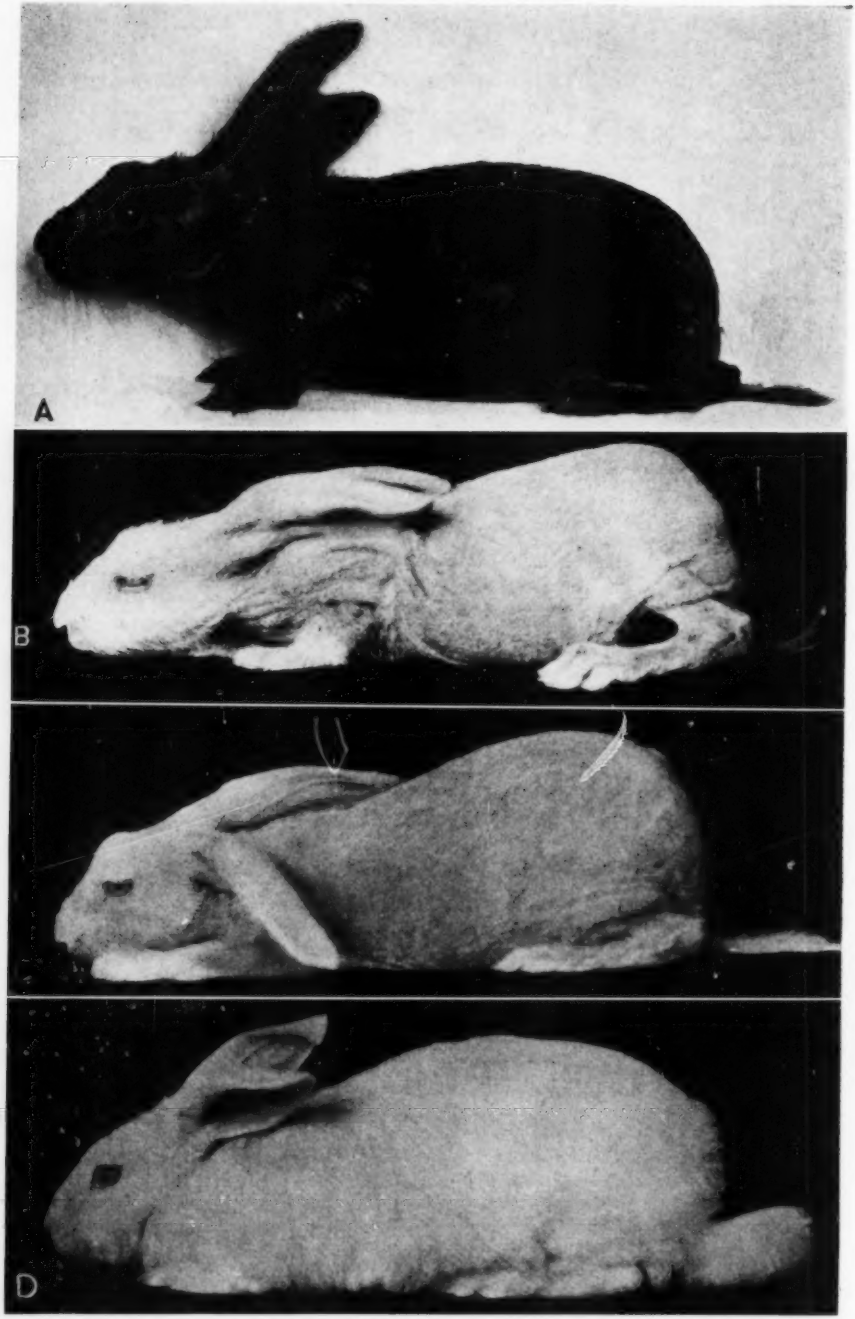

LITTER MATES—NORMAL AND FURLESS

Furlessness is a recessive gene that is not linked with any known genes, except possibly blood group genes. *A*—A black furless rabbit; *B*—A Vienna White furless rabbit; *C*—Another Vienna White furless rabbit; *D*—A normal Vienna White rabbit. All four of these rabbits are litter mates, photographed when they were 83 days old. The furless gene causes the developing hairs to undergo premature keratmization. As a result only the long guard hairs emerge from the skin.

THE FURLESS RABBIT

W. E. CASTLE*

Bussey Institution, Harvard University

THE name *furless* was given by Prof. John Hammond to a mutation which he discovered in a race of inbred rabbits at Cambridge University, England. In October, 1929, he kindly sent me a stock of these rabbits through arrangements made by our mutual friend, Dr. Gregory Pincus, it being my purpose to investigate the linkage relations of the single recessive gene which Hammond had shown to be involved in the mutation. The consignment consisted of a pair of furless black rabbits and two pairs of normal appearing black rabbits heterozygous for furless. Concerning them Prof. Hammond sent me the following notes:

At birth furless can be distinguished from normals by (1) absence of any hairs except the whisker and eyebrow hairs and (2) shiny and pale colored skin. As the furless grow up, they gradually develop the long outer hairs all over the body (the rate of development is variable) but do not grow any fur [woolly fine and soft short under fur]. The tip of the nose, feet, and tail soon develop a quite normal appearance, but the rest of the body grows hairs (outer coat) but no fur, although the fur follicles are present in the skin.

The mutation furless, I believe, is similar to that which turned up in Kislovsky's experiments (*Journ. Heredity*, 19, Oct., 1928) and was described by him as "naked" and lethal. I have had quite a number of unthrifty animals of this sort which have died at about the time he describes but have reared about ten to a year old and of these, three or four of each sex have produced young. When mated to normal haired, they have given all normal young; and when mated to furless, all furless young. The character seems to be a simple recessive to normal hair.

The discovery of the mutation has been one of the results of a series of inbreeding experiments; other characters also, such as fatal atrophy, hydrocephalus, "open" or absence of fusion of the neural canal, split penis, etc., are in process of separation. For this purpose mother × son matings are found more effective than brother × sister. This strain has been selected on the basis of low birth weight; i. e., the larger ones of each litter are killed off and only the small ones are reared.

I am able to confirm the observations recorded by Professor Hammond concerning this curious mutation. From the pair of furless animals sent me I was, however, unable to obtain young. Likewise, matings of the furless male with normal females produced no young, and toward the end of the winter (1929-30), I lost both furless individuals. I attribute this loss and the apparent sterility of the furless male to the low temperature of our rabbit room at this season. The furless male had a prodigious appetite and consumed great quantities of food, but apparently the energy of his food was diverted to heat production, and none was left for reproduction, though he showed normal sex instincts, but produced no motile sperm, so far as we could discover.

From the heterozygous males sent to me, numerous young were obtained in matings with normal females, all the young having normal coats, as expected. Half of them might be expected to carry the furless gene as a recesssive. As soon as the F_1 females were old enough, they were backcrossed to the heterozygous males, and eighteen of them were thus identified as carriers of furless, by the fact that one or more furless young were produced by them. Seventeen other F_1 females produced no furless young in the test matings, from which it may be inferred that they were not carriers of the furless gene. The ratio 18 carriers to 17 non-carriers is in complete agreement with the expected 1:1 ratio.

*My thanks are due to Drs. C. E. Keeler and P. B. Sawin for making the photographs reproduced in the figures.

It is easy to distinguish the furless young at birth by the criteria mentioned by Professor Hammond, the smooth shiny skin and its paler color. In 27 test matings between heterozygous males and females which proved to be also heterozygous, there were produced 191 young of which 135 were normal and 46 furless. The Mendelian expectation of furless in this number of young is 47.75 from which the observed number deviates by only 1.75, the probable error being 4.04. In other words, the agreement is statistically perfect, confirming Hammond's finding that furless is a simple recessive character. There is no indication that furless is lethal or at all harmful prior to birth.

The principal object in view in my experiments with furless, as already stated, was to discover whether the gene for furless is genetically linked with any other gene or genes of the rabbit, of which, apart from multiple allelomorphs, thirteen are known. These thirteen genes are, according to present information, located in eight or nine different chromosomes.

For the purpose of making a test for linkage, individuals have first to be produced which are heterozygous for both the genes whose linkage relations are being investigated. An F_2 generation produced by such doubly heterozygous individuals usually suffices to show whether linkage exists. If it does exist, there will be a statistically significant departure from a dihybrid Mendelian ratio, the recombination classes being deficient. If they are not deficient, or are in excess of expectation, no evidence of linkage is found. The backcross of a double heterozygote with a double recessive is an even better test for linkage but can not be made unless the double recessive already exists or has been synthesized, which may be a slow process if linkage occurs. Also, in the case of the furless character, homozygotes are difficult to keep alive and of doubtful fertility. Hence, in most of the tests for linkage thus far made, only F_2 populations have been studied. The mutant genes with which tests for linkage were desired are as follows: (1) non-agouti; (2) brown (or albino, or yellow fat, which are linked with brown); (3) dilute; (4) yellow; (5) English (or Dutch, or angora, which are linked with English); (6) Rex; (7) Kurzhaar; (8) Vienna White; (9) A blood group gene.

Double heterozygotes have been produced for furless in association with each of the nine genes mentioned, and F_2 or backcross tests for linkage have been completed in the case of all except the last. The evidence yielded by these tests is as follows:

(1) *Agouti.* The original furless consisted of non-agouti animals. Crosses were made with gray or black-and-tan animals carrying a dominant agouti allelomorph. These agouti F_1 animals were then backcrossed with the original non-agouti animals. With free segregation there would be expected a ratio of 3 agouti normal : 3 non-agouti normal:1 agouti furless:1 non-agouti furless. Both parents in the back-cross were heterozygous for furless; hence the expectation of 3 normal:1 furless. But only one parent was heterozygous for agouti, the other being non-agouti; hence the expectation 1 agouti:1 non-agouti. In a total of 53 such backcross litters, there were produced 329 young, distributed as shown in Table 1*.

In two of the four classes of young the deviation from expectation is less

*TABLE I. Distribution of Agouti × Furless Backcross.

	Agouti normal	*Non-agouti normal*	*Agouti furless*	*Non-agouti furless*
Observed	131	122	36	40
Expected	123.4	123.4	41.1	41.1
Deviation	+7.6	—1.4	—5.1	—1.1
P.E.	6.07	4.78	4.78	2.96
Dev./P.E.	1.25	.29	1.06	.37

than the probable error; in the other two classes, it is only slightly greater than the probable error. In no case is the deviation statistically significant, or suggestive of linkage between the gene for furless and the gene for agouti.

(2) *Brown.* A cross was made between a chocolate normal rabbit and a black heterozygous for furless. Two of the F_1 blacks doubly heterozygous for brown and for furless produced, in three litters, a total of 21 young, distributed as shown in Table II*.

In every class the deviation from expectation is less than the probable error; hence there is no indication of linkage between the gene for brown and the gene for furless.

(3) *Dilute.* The original furless stock consisted of animals homozygous for intensity. A cross with dilute animals produced F_1 intense animals doubly heterozygous for dilution and furless. An F_2 generation from such F_1 parents consisted of 85 young, born in 12 litters (Table III†).

There is here an excess of furless young over expectation in both the intense and dilute classes and a corresponding deficiency of intense normals, but the deviations are not such as to suggest the existence of linkage; for the dilute furless class, which alone could arise solely from the union of crossover gametes (dilute and furless), is greater than expected. If linkage (repulsion) occurred between the genes for dilution and furlessness, such gametes and zygotes should be fewer rather than more numerous than the calculated numbers.

(4) *Yellow.* A cross of normal yellow rabbits with blacks heterozygous for furless produced non-yellow (black or gray) F_1 animals with normal coats. An F_2 generation of 40 litters from F_1 animals heterozygous for both yellow and furless consisted of 286 individuals, distributed as shown in Table IV‡.

The agreement with expectation is extremely close. In no class is the deviation as great as the probable error. Hence yellow and furless are clearly not linked since they recombine freely.

(5) *English.* A cross of English with furless produced F_1 English normal animals, English being a dominant character and furless recessive. A

*TABLE II. F_2 Brown × Furless Cross.

	Black normal	*Brown normal*	*Black furless*	*Brown furless*
Observed	12	3	4	2
Expected	11.7	3.9	3.9	1.3
Deviation	+.3	—.9	+.1	+.7
P.E.	1.53	1.21	1.21	.75

†TABLE III. F_2 Dilute × Furless Cross.

	Intense normal	*Dilute normal*	*Intense furless*	*Dilute furless*
Observed	35	15	24	11
Expected	47.7	16	16	5.3
Deviation	—12.7	—1	+8	+5.7
P.E.	3.08	2.43	2.43	1.51
Dev./P.E.	4.1	.41	3.2	3.7

‡TABLE IV. F_2 Yellow × Furless Cross.

	Non-yellow normal	*Yellow normal*	*Non-yellow furless*	*Yellow furless*
Observed	159	56	54	17
Expected	160.9	53.7	53.7	17.9
Deviation	—1.9	+2.3	+.3	—.9
P.E.	5.66	4.45	4.45	2.76

TABLE V. Backcross of (F_1 English × Furless) Cross.

	English normal	*English furless*	*Self normal*	*Self furless*
Observed	20	23	3	8
Expected	20.25	20.25	6.75	6.75
Deviation	—.25	+2.75	—3.75	+1.25

backcross of such F_1 animals with self black normals heterozygous for furless produced 6 litters of young, 54 individuals, distributed as shown in Table V.

We expect here, with free recombination, a 3:3:1:1 ratio, which is closely approximated.

A still better test for linkage was made by a backcross of F_1 English does with a double recessive buck, self furless. This backcross produced, in 10 litters of young, 79 individuals, distributed as shown below*.

All classes are here expected to be of the same size, if no linkage occurs. The combined crossover classes (English furless and self normal) number 41; the non-crossover classes (English normal and self furless) include 38 individuals.

In both English backcrosses, we expect equal numbers of crossover and non-crossover individuals; hence we may properly combine their results. This gives us a total of 67 crossover to 66 non-crossover individuals, or complete independence of the English and furless genes.

(6) *Rex.* Rex is a recessive mutation recognizable at birth in the curliness of the vibrissæ, and later in the shortness of the coat. A cross of rex with furless produced normal coated individuals heterozygous for both genes. An F_2 generation consisted of 387 individuals, born in 51 litters and distributed as shown in Table VI†.

No class deviates significantly from the expected dihybrid Mendelian ratio. The three classes of recessives, rex, furless, and rex furless are in the exact theoretical proportions of 3:3:1. The double dominant group is slightly but not significantly below expectation. Free segregation and recombination of rex and furless is clearly indicated.

(7) *Kurzhaar.* A rex-like mutation to short hair and curly whiskers, known by its German name as Kurzhaar, has also been tested for linkage with furless, likewise with negative results. The F_1 animals are normal, as in the cross with rex. An F_2 generation has been produced consisting of 14 litters, including 107 individuals‡.

No class deviates significantly from expectation based on the assumed independence of kurzhaar and furless.

There are, in certain other experiments, clear indications, which will be more fully explained elsewhere, that the genes for rex and kurzhaar are borne in the same chromosome and are closely linked with each other. If so, they should have similar linkage relations with any other gene, such as furless. Hence it would be legitimate to combine the tests of rex and of kurzhaar for linkage with furless. If this

*TABLE V*A*. Backcross F_1 English × Furless.

English normal	*English furless*	*Self normal*	*Self furless*
17	14	27	21

†TABLE VI. F_2 of Rex × Furless Cross.

	Normal	*Rex (not furless)*	*Furless (not rex)*	*Rex furless*
Observed	198	81	81	27
Expected	217.7	72.5	72.5	24.2
Deviation	—19.7	+8.5	+8.5	+2.8
P.E.	6.6	5.2	5.2	3.2
Dev./P.E.	2.9	1.6	1.6	.8

‡TABLE VII. F_2 of Kurzhaar × Furless Cross.

	Normal	*Kurzhaar (not furless)*	*Furless (not kurzhaar)*	*Kurzhaar furless*
Observed	55	27	21	4
Expected	60	20	20	6.7
Deviation	—5	+7		
P.E.	3.5	2.7	+1	—2.7
Dev./P.E.	1.4	2.5	.3	1.5

is done, we have an F_2 population of 387 plus 107, or 494 individuals, distributed as shown in Table VII*A**.

The double recessive recombination class, short-hair furless, is in perfect agreement with expectation. Into it only cross-over gametes could enter; hence it gives strong evidence against the occurrence of linkage. The single recessive classes, short-hair and furless, are also in satisfactory agreement with expectation. Only the double dominant class (normal) deviates noticeably from expectation, but doubtless this is due to random sampling or some agency other than linkage.

(8) *Vienna White.* Vienna white, like most of the other rabbit mutations involved in these experiments, is recessive. Hence in crosses between Vienna white and furless, normal offspring are obtained, and the regular dihybrid ratio, 9:3:3:1, is expected in F_2, if no linkage occurs between these two genes. An F_2 population has been produced consisting of 129 individuals, born in 16 litters and distributed as shown in Table VIII†.

The double recessive recombination class is in excess of expectation, indicating a full complement of crossover gametes, but no class deviates significantly from the regular dihybrid ratio.

(9) *Blood Group Genes.* Only the blood group genes remain to be tested for linkage with furless. Such tests are in progress. Two blood group genes have been found in rabbits. Both are borne in the same chromosome, as is shown by experiments to be described elsewhere. Unless linkage is found to exist between the blood group genes and furless, we shall be forced to conclude that the gene for furless is not found in the same chromosome with any of the other genes thus far identified in the domestic rabbit.

As to the correctness of the suggestion made by Hammond that furless is probably identical with the mutation described by Kislovsky under the name of *naked,* doubt continues to exist, since histological studies of the two mutations are not in entire agreement. Mrs. L. T. David studied the skin of a specimen of naked supplied by Kislovsky, and reports it to be *"very thin, with follicles few in number and irregularly directed."* Mrs. Elizabeth East Drapeau (unpublished observations) has studied specimens of furless at various ages pre- and post-natal and finds, in agreement with Hammond, that abundant hair follicles are present in the skin, but that the developing hairs undergo premature keratinization and fail to emerge from the skin, as a rule, except in the case of the larger guard hairs. It seems quite possible, therefore, that naked and furless, like rex and kurzhaar, though they produce similar phenotypic effects, may be due to different gene mutations.

Summary

Furless, as shown by Hammond, is a recessive mutation of the domestic rabbit. Linkage studies show that its gene is not borne in the same chromosomes as agouti, brown, dilution, yellow,

*TABLE VII*A*. Combined Rex and Kurzhaar data.

	Normal	*Short-hair (not furless)*	*Furless (not short-hair)*	*Short-hair furless*
Expected	253	108	102	31
Observed	277.9	92.6	92.6	30.9
Deviation	24.1	15.4	9.4	.1
P.E.	7.4	5.8	5.8	3.6
Dev./P.E.	3.2	2.6	1.6	.02

†TABLE VIII. F_2 of cross of Vienna White × Furless.

	Normal	*V. W. (not furless)*	*Furless (not V. W.)*	*V. W. furless*
Observed	67	22	29	11
Expected	72.5	24.2	24.2	8.1
Deviation	—5.5	—2.2	+4.8	+2.9
P.E.	3.8	3.0	3.0	1.8
Dev./P.E.	1.4	.7	1.6	1.6

English, rex, kurzhaar, or Vienna white. Its relation to the blood group genes remains to be determined.

Literature Cited

CASTLE, W. E. 1930. The genetics of domestic rabbits. Harvard Univ. Press, Cambridge, Mass.

DAVID, LORNA THIGPEN. 1932. The external expression and comparative dermal histology of hereditary hairlessness in mammals. *Zeit. f. Zellforsch. u. mik. Anat.* 14, 616-719.

KISLOVSKY, D. A. 1928. Naked—A Recessive Mutation in the Rabbit. *Jour. Heredity* 19, Oct. 1928.

PICKARD, J. N. and F. A. E. CREW. 1931. The scientific aspects of rabbit breeding. Watmoughs, Ltd., Idle, Bradford, England.

Chromosomes of the Potato

THE rather involved history of the introduction of the potato into Europe and North America and its adoption into the dietaries of the world has already been given in this Journal.*

Apparently the chromosomes of the potato are as complicated as its history, to judge by a summary of the cytological work on this species by Arne Müntzing, of the Svalöf Experiment Station, in *Hereditas*, Volume 17, Number 2, 1933. Dr. Müntzing follows this with an account of his own work,—which adds much to our knowledge of chromosomal behavior in this species.

It appears that all the commercial varieties of potatoes in cultivation in Europe and North America are tetraploids, with a somatic chromosome number of forty-eight. Most of the varieties found in the Andes of Peru and Bolivia* also have this chromosome number. A few varieties that are diploids and triploids, with a somatic chromosome number of twenty-four and of thirty-six have also been discovered.

Since a majority of the forms cultivated today in Europe and North America owe their origin to a few early importations it seems very likely that the indigeous forms from Peru and especially the diploids and triploids offer extremely valuable material for the plant breeder. A recent expedition to Peru to obtain some of these potato varieties should make new material available to breeders. A really comprehensive program of potato improvement would seem to require a wide range of both diploids, triploids and tetraploids for experimental purposes.

The chromosomes of the potato are small and are usually joined only by a single chiasma at meiosis. In the triploid and tetraploid forms chains of three or four chromosomes are common. This is taken to indicate that the chromosomes are essentially duplicates not much altered by translocation and inversion.

Secondary association of potato chromosomes after reduction has taken place, is a phenomenon which is abundantly confirmed by Müntzing. From this it is inferred that the basic chromosome number, 12, represents the duplication of a primitive six-chromosome form. The genus *Solanum* itself offers no confirmation of this speculation, as all known species have 12 or more chromosomes. Some related genera, such as the petunia, have a smaller number, which is believed to lend plausibility to the view that the ancestor of the potato may have had less than twelve chromosomes. R. C.

SAFFORD, W. E., "The Potato of Romance and of Reality," *Journal of Heredity*, Vol. 16, Pages 113-230, 1925.

*For illustrations of some of the native Peruvian varieties see COOK, O. F., Domestication in Peru, *Journal of Heredity*, 16:33-46; 95-110, and by the same author: Staircase Farms of the Ancients, in *National Geographic Magazine*, May, 1916, 474-534.

RUSSIAN METHODS OF ARTIFICIAL INSEMINATION MULTIPLY SIRES' VALUE

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RECENTLY we have had occasion to obtain detailed information concerning the methods which at present are used in Russia for the artificial insemination of sheep. A short description of these methods is given in the following paragraphs.

Elias Ivanov developed the first method for artificial insemination of domestic animals. His method at first was used chiefly for horse breeding (to a certain extent also outside of Russia), but was later applied with slight modification to other animals. A number of new methods have been worked out within recent years.

The need for artificial insemination arose in Russia chiefly on account of the great distances in rural districts which frequently made it impossible to use valuable breeding animals to best advantage. The present economic program of Russia, calling for rapid improvement of existing native livestock, makes it especially imperative to use the expensive pure-bred herd sires which have been imported from foreign countries to the greatest possible extent in grading-up unimproved herds. This gave new impetus to attempts at perfecting the methods of artificial insemination.

Aside from the specific needs of Russia, however, it seems probable that artificial insemination will play an important rôle in the future of livestock breeding in general, since it will enable breeders to make much more rapid progress towards reaching the goal of their breeding program. In any breed of cattle, for instance, not more than a few outstanding sires at best exist at any time. Even after their value has become known by the progeny test, their usefulness to the breed is limited by the relatively small number of offspring which can be obtained by natural reproduction. There is no need of emphasizing how much could be gained if the number of offspring of such animals could be increased five or ten times. This is exactly what artificial insemination will enable the breeder to do, and it is chiefly with this in mind that the following description of methods is offered.

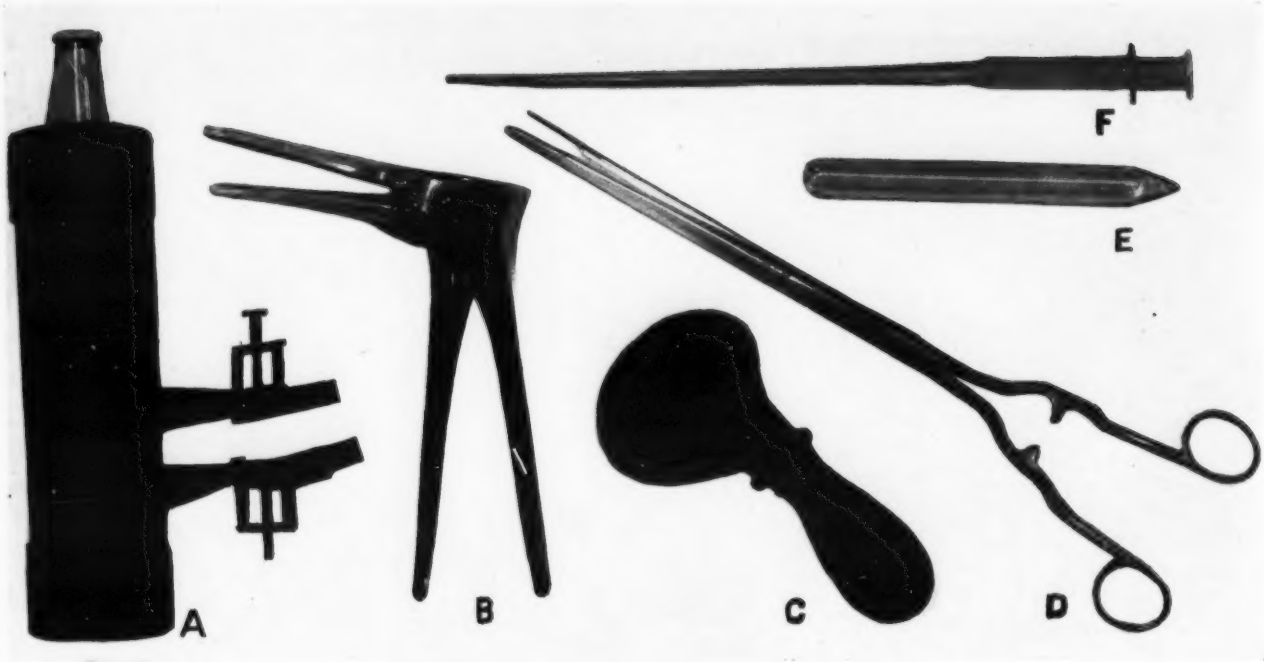
Although these methods have been specially worked out for sheep, very similar ones are used in Russia for horses, cattle and pigs.†

1. The Sponge Method of Ivanov

A Greek velvet sponge is cut into small pieces, each somewhat larger than a walnut. These sponges are cleaned and put over night into alcohol (65%). The following morning the alcohol is squeezed out with a press. They are then washed five times in a solution of ten grains of sodium chloride C.P. and five grains of sodium bicarbonate to one tablespoonful of pure distilled water. Following this, the sponges are three times soaked in a sugar solution, the fluid being squeezed out again each time. The sugar solution is prepared as follows: 106 grains of powdered refined sugar are dissolved in a tablespoonful of distilled water. After filtering, one grain of sodium chloride is added to it, and the solution is then three times brought to boiling over a

*The writer is indebted to Amtorg Trading Corporation (261 Fifth Avenue, New York City) and to Institut Jiwotnovodstwa, Laboratoria Iskustvennoge O Semeneia in Moscow, through whose kindness most of the above information and a set of instruments were obtained.

†Some methods for artificial insemination of horses have been described by W. S. Anderson in Kentucky Agricultural Experiment Station Bulletin No. 244, 1922.



INSTRUMENTS FOR ARTIFICIAL INSEMINATION

Figure 1

A—Artificial vagina; *B*—Vaginal speculum; *C*—Sperm collector; *D*—Pincers; *E*—Test tube containing solution for diluting sperm; *F*—Special syringe.

slow fire. To the cooled solution is added 0.5 grain of sodium bicarbonate. This solution is to be prepared fresh each time. The sponges are finally put into a sterilized glass jar which is tightly corked. When a sponge is to be used, it is taken from the glass jar with sterile pincers (Figure 1, *D*) and with the help of a vaginal speculum (Figure 1, *B*) introduced into the vagina of a ewe. After the ewe has been served, the sponge is extracted again with the pincers and the sperm is squeezed from it into a glass container. Sperm is then taken up into a special Luer syringe with a capacity of 2 cc. (Figure 1, *F*) and with it transferred into the uterus of the ewe to be inseminated. The syringe, before using it, is washed with alcohol (65%) and rinsed several times with physiological salt solution. The tip of the syringe is washed with alcohol and dried with sterile cotton. For insemination the syringe is held in the right hand, the speculum in the left hand. The speculum is sterilized in the flame of a Bunsen burner. The ewe which is to be inseminated is put into the breeding rack (Figure 2*A* and *B*). The cervix of the uterus is located with the speculum. The syringe is introduced into the uterus to a depth of about one centimeter. Approximately 0.2 to 0.4 cc. of sperm are used for one ewe. After each insemination the speculum is washed with alcohol and sterilized with a Bunsen burner, and the outside of the syringe is wiped with cotton soaked in alcohol and dried with sterile cotton. After the contents of the syringe is all used up, the syringe is washed with physiological salt solution and filled with alcohol which remains in it until the syringe is needed again.

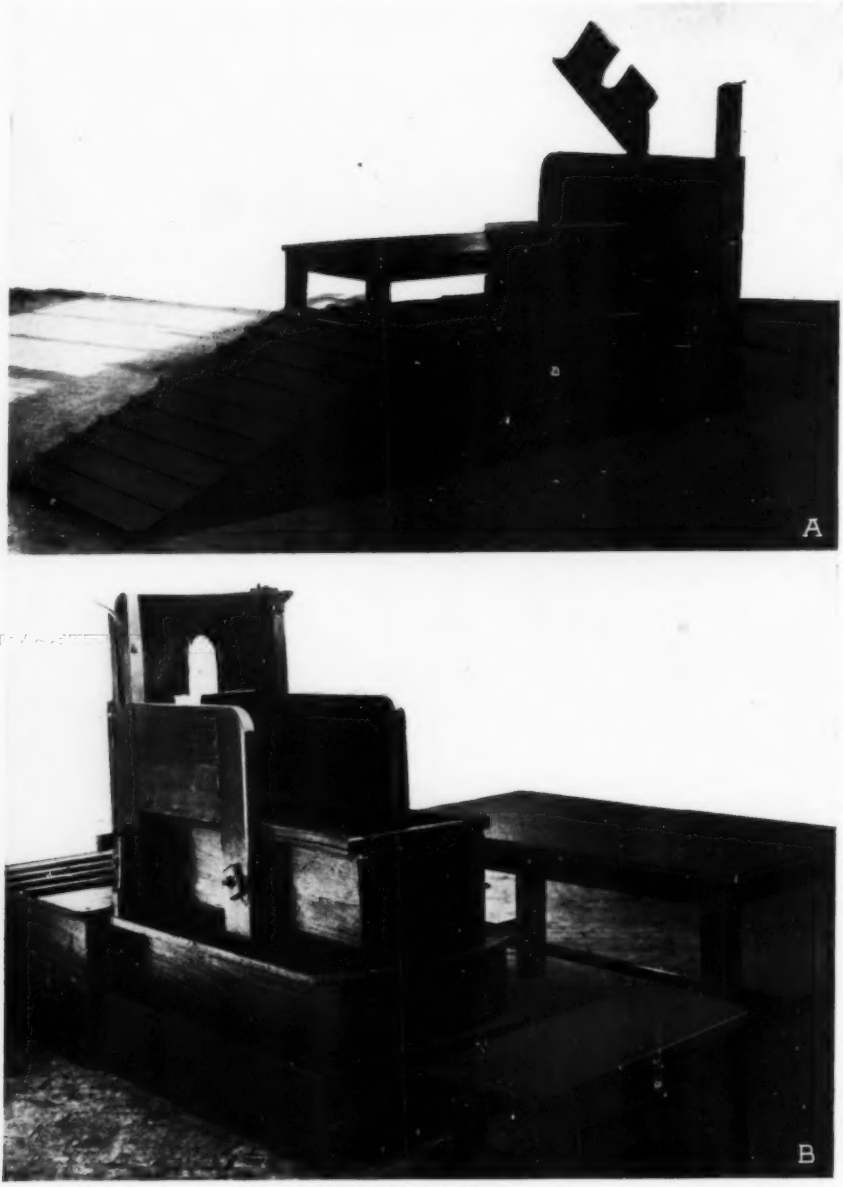
The use of the sponge method of Ivanov has been discontinued in Russia recently because only a small part of the sperm ejaculated by the ram is recovered and because many of the spermatoza are damaged when the sperm is squeezed out of the sponges. However, the method of insemination, as outlined above, is in general use regardless of the way in which the sperm has been obtained.

The following new methods have been worked out by the Institute for Artificial Insemination in Moscow (Institut Jiwotnovodstwa, Laboratoria Iskustvennoge O Semenenia, Petrovsky Park, Istominsky Proezd, Moscow, U.S.S.R.).

2. The "Sperm Collector" Method

The "sperm collector" (Figure 1, *C*) is made of soft rubber but has near its upper end a fairly hard rubber ring which holds the instrument in place after it has been inserted into the vagina. The top consists of a fairly large flat rubber disk which covers the entire outer surface of the vagina. The procedure with this equipment is as follows. The sperm collector is washed; then it is for ten minutes put into alcohol (65%); after the alcohol has been drained off, it is for a short time put into alkaline physiological salt solution; after this in turn has been drained off, the sperm collector is kept in a sterile glass jar until needed. Just before using the sperm collector, its entire inner and outer surface is covered with sterile white or yellow vaseline or vaseline oil. It is important that the inner surface is completely covered with vaseline. No borated vaseline or other substitutes should be used since they may damage the sperm. The sperm collector is then introduced into the vagina with the help of the pincers. The firm rubber ring of the collector must come to lie past the muscular part of the vagina. After the ewe has been served, the sperm collector is removed and the sperm is taken up with the syringe.

The collector is washed at once in warm water containing 2 per cent of soda; after this, it should be washed in a solution of sodium bicarbonate, rinsed in water and allowed to dry. The vaseline should never stay on the collector for more than fifteen minutes at a time; if it stays too long it may des-



BREEDING RACK

Figure 2

A—ready to receive the ewe. *B*—the breeding rack in position for artificial insemination of the ewe. The rack is closed after the ewe has entered it, and with the help of a revolving mechanism is turned 180° in order to bring it into a more convenient position for inseminating the ewe. Photographs courtesy Institute of Artificial Insemination, Moscow.

troy the rubber. The sperm obtained in this way, is used as described in method 1. Russian experience has shown that the method of getting the sperm with this sperm collector is the most successful one, and it has been adopted in Russia for all occasions where large numbers of ewes are to be inseminated. About ten times as much sperm can be obtained with the sperm collector as with the sponge method. Moreover, the motility and length of life of the sperm outside of the organism is much greater if the sperm is collected with the sperm collector. During 1931 this method was used in Russia for the insemination of several hundred thousand sheep and of about 187,000 cows; it has also been used for horses and donkeys.

3. The Speculum Method

If only a few ewes are to be inseminated for experimental purposes, the sperm can be obtained from the vagina directly with the speculum. A ewe is put into the breeding rack and the ram is allowed to mate with her. The speculum, sterilized with a Bunsen burner, is introduced into the vagina of the ewe, holding the handles of the speculum in a horizontal position. The spoon-like lower part of the speculum collects the sperm. The handles of the speculum are then turned to the vertical position and the instrument is withdrawn. The sperm is transferred into a sterile watch glass or other glass container, and is used for insemination as described above.

4. The "Artificial Vagina" Method

In a fourth method, which at present is employed chiefly for experimental purposes, the so-called "artificial vagina" is used. This instrument (Figure 1, *A*) consists of an outer hard-rubber tube and an inner tube of soft rubber. A small graduated glass is inserted at one end. Before use, the instrument is wiped with a sterile sponge dipped in alcohol (65%); the glass receptacle also should be sterile. The space between the outer and inner tube is half filled with warm water (45°C) through one of the two small side tubes and one of the clamps on the side-tubes is tightened. Next, air is blown in through the second side-tube until the inner soft-rubber tube of the artificial vagina forms a vulva-like protrusion at the opening opposite to the glass receptacle. The second clamp is now tightened. The inner surface of the instrument is covered with sterile vaseline. The instrument is interposed between ewe and ram when the ram leaps upon the ewe. The sperm is obtained from the glass receptacle with the syringe and is used for insemination as described before. The instrument should, of course, be carefully cleaned and dried after it has been used. This artificial vagina is used in Russia not only in sheep breeding but also for the insemination of sows.

Irrespective of the method with which the sperm has been obtained, a microscopic examination of the sperm (magnification 180 to 200 times) should be made before the sperm is used for insemination. If there are no motile spermatozoa, the sperm should not be used. If only few motile spermatozoa are present, the sperm should be used without dilution. However, if a large number (hundreds) of motile spermatozoa can be seen in the field of vision, the sperm should be diluted before it is used. The examination of the sperm should be made immediately after obtaining it and at a temperature of not less than 15°C. Dilution of the sperm is made with a mixture of special glucose and phosphate solutions, supplied by the Russian institute. These solutions are supplied in sealed test tubes (Figure 1, *E*). The contents of one tube of glucose solution and of one tube of phosphate solution are mixed and the sperm is diluted with this mixture in a proportion of from 1:2 to 1:8.

The dilution fluid should have a temperature of from 15-25° C. Especially good results have been obtained in sheep with a dilution fluid containing mucin, while for cattle it proved most success-

ful to use a dilution fluid containing peptone-lipoids. Dilution of the sperm up to 1 : 1000 is possible, and a maximum of 2,734 sheep has been inseminated from one ram during a single breeding season. In cattle also dilution of the sperm up to 1 : 1000 is possible. A dilution of 1 : 160 did not appear to have any adverse effect upon the percentage of pregnancies obtained.

It is suggested that rams are allowed a normal copulation once in about ten days.

Large scale inseminations are made on the ranges of the Sheep Trust. During 1930 it was found that the sperm of a single ram when fully utilized was sufficient to inseminate from 300 to 400 ewes during one season. One service of the ram, on the average, gave enough sperm to inseminate six ewes. About 90 per cent of all ewes inseminated became pregnant, which is as high or nearly as high as can be expected under normal breeding conditions. As many as 400 cows can be inseminated from a single service of a bull, and as many as 1,250 cows actually have been inseminated from one bull in the course of a year.

For all of the insemination methods it is important that all of the manipuations of obtaining the sperm and of inseminating the ewes are carried out in a room with a temperature of not less than 15° C. but preferably between 15 and 25° C. Temperatures of 10° C. or less are harmful to the sperm.

Ordinarily, the possibilities of utilizing the sperm will be limited by the available number of animals which are in heat. Experiments have been made, however, concerning the possibility of keeping valuable sperm. With a special glucose phosphate dilution fluid and at a temperature of from 10-15° C. it was found that ram sperm could be stored for 18 days and still be used for successful insemination. Studies are being made in Russia also concerning the possibility of inducing heat periods experimentally.

FIFTH WORLD POULTRY CONGRESS

WE are in receipt of the provisional announcement of the Fifth World Poultry Congress to be held in Rome September 6-15, 1933. The announcement, dated March 21, seems hopelessly late, for we learn that: "The titles of the papers to the various Sections must be transmitted to the Secretary General together with the name and address of the contributor, before December 31, 1932. The total number of these papers is limited to 100. The text of the papers and of the general reports must reach the Secretary General before March 31, 1933, in order to allow time for their printing." It is obviously impossible for American workers to comply with this request. The broadcasting of an invitation to submit papers three months after the closing date should enormously simplify the work of the Program Committee.

"All Nations intending to participate in the Fifth World Poultry Congress, and Exhibition should proceed, without further delay, to the constitution of their own National Committee which will be entrusted with the organization of their participation in the Congress and which should keep in contact with the Italian General Committee.

"All communications referring to the Congress or to the Exhibition should be addressed as follows: Al Segretario general del V Congresso ed Esposizione mondiale de Pollicoltura presso il Ministero dell'Agricoltura e delle Foreste, Rome (Italy)."

There will be six sections to discuss the following topics:

1. General and genetic questions; 2. Physiology, nutrition and breeding; 3. Hygiene and diseases; 4. Instruction and organization; 5. Economic problems and trade in poultry products; 6. Rabbit raising.

Subscription fees are fixed at 75 Italian Lira ($3.90 at present rates of exchange). Subscription to the Congress must be made through the respective National Committees.

INBREEDING AND INTERCROSSING IN POULTRY

The Effects, on Various Characters, of Close Inbreeding and of Intercrossing Closely Inbred Lines of White Leghorns

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FROM the practical standpoint the results secured in experiments on inbreeding and outbreeding poultry are of interest to the poultry breeder because frequently he is in a quandary as to whether he should use breeding stock from his own flock or whether he should purchase breeding males from an outside source. Sometimes the poultry breeder is also in a quandary as to whether or not he should mate males and females that are related. If such be desirable for a particular purpose in mind, there is still the question as to how closely related the males and females may be in order to secure the most satisfactory results.

Should a sire be mated to his daughters, dam to son, brother to sister, cousin to cousin, or should other forms of inbreeding be practiced in an effort to improve the average egg production of a flock or to improve any other character in the flock? These are some of the questions in the minds of many poultry breeders with the approach of every breeding season.

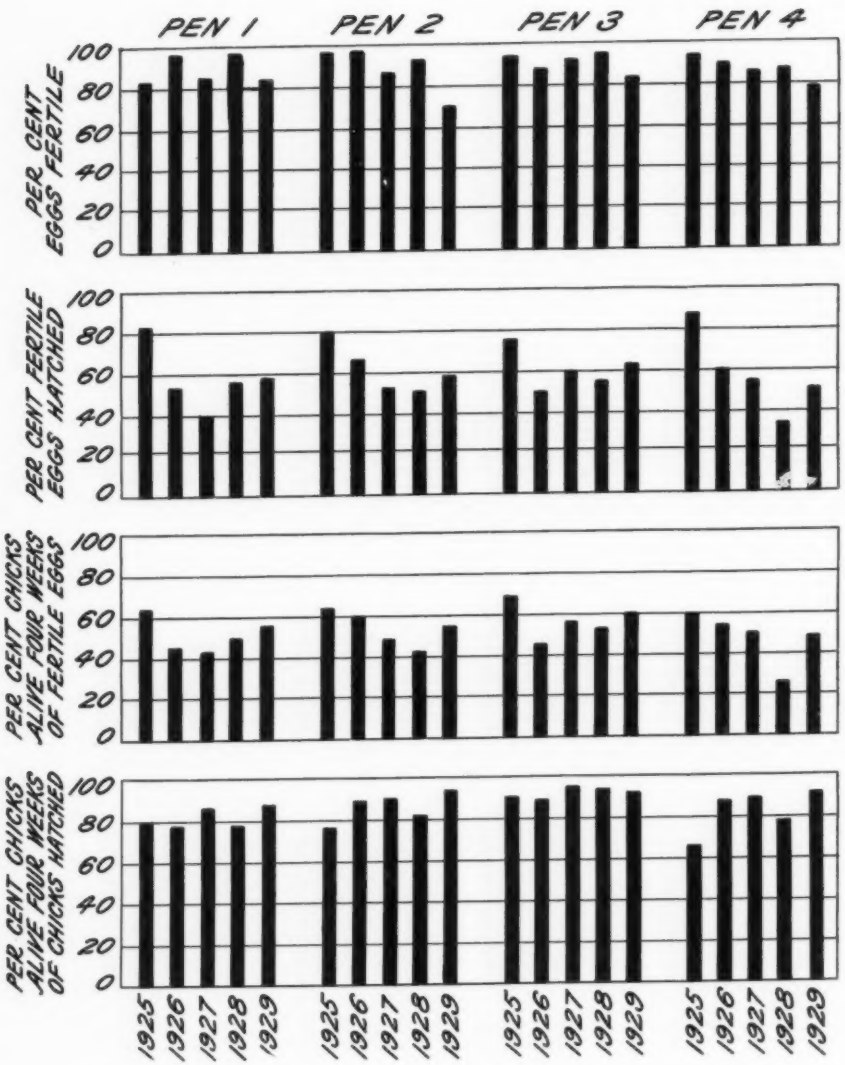
What Constitutes Inbreeding?

By inbreeding is meant the mating of related individuals. "In other words, *the inbred individual possesses fewer different ancestors in some particular generation or generations than the maximum possible number for that generation or generations.*" According to Pearl[15] this appears to be the most general form in which the concept of inbreeding may be expressed.

If a bird's parents are not related, its four grandparents are all different and its eight great-grandparents and sixteen great-great-grandparents are also all different. The number of ancestors is doubled for each generation further removed from the individual, so that in the twenty-fifth ancestral generation there are 33,554,432 different ancestors. On the other hand, if a bird's parents are related, the number of ancestors in one or more of the ancestral generations is less than the greatest number possible. For instance, a bird which is the progeny of a half-brother × half-sister mating has three instead of four different grandparents.

Caution must be exercised in discussing the effects of inbreeding because in nearly all cases the term inbreeding can be used in a relative sense only. In the case of poultry, for instance, all chickens are probably related among themselves to some extent, just as probably all ducks are related among themselves and all turkeys are related among themselves. Moreover, in the case of the domestic fowl, undoubtedly all Barred Plymouth Rocks are more closely related among themselves than they are related to other varieties of Plymouth Rocks or to other breeds of domestic fowls.

Although all birds of the same variety are related among themselves, it is quite obvious that the amount of inbreeding is greater in a flock in which breeding work has been carried on for several years without the use of males from outside sources than in the case of another flock of the same variety in which breeding work for the same length of time involved the use of males from a different source each year. The amount or degree of inbreeding increases as the birds mated are more closely related. The mating together of full brothers and sisters



EFFECTS OF INBREEDING ON REPRODUCTIVE CHARACTERS

Figure 3

Graphs showing the effects on characters associated with reproduction of full brother × full sister matings, and of half brother × half-sister matings for three years, and of intercrossing inbred pairs in the third year. That is, after inbreeding Pen 1 for three years (1926, 1927, 1928), a male from Pen 1 was mated with females from Pen 2 in 1929, etc.

produced by a full-brother × full-sister mating is the closest form of inbreeding that can be practiced.

Inbreeding Effects in Chickens

Only a few carefully controlled experiments on inbreeding chickens have ever been undertaken although the results secured are very interesting. Cole and Halpin[2] inbred Rhode Island Red full-brothers and full-sisters for four years and observed that in the fourth year hatchability was so low that the experiment had to be discontinued. The basis of selecting the full brothers and sisters each year was the color of the plumage over the back. Another inbreeding experiment by Cole and Halpin[3], was started with Rhode Island Reds in which full brothers and sisters were selected for subsequent matings based on the hatchability of the eggs and the viability of the chicks produced by the dams, these two characters having been assumed to be a measure of the constitutional vigor of the parent stock. The detailed results of these experiments have not been published although Cole[1] has stated that hatchability decreased to such an extent that the experiment had to be discontinued.

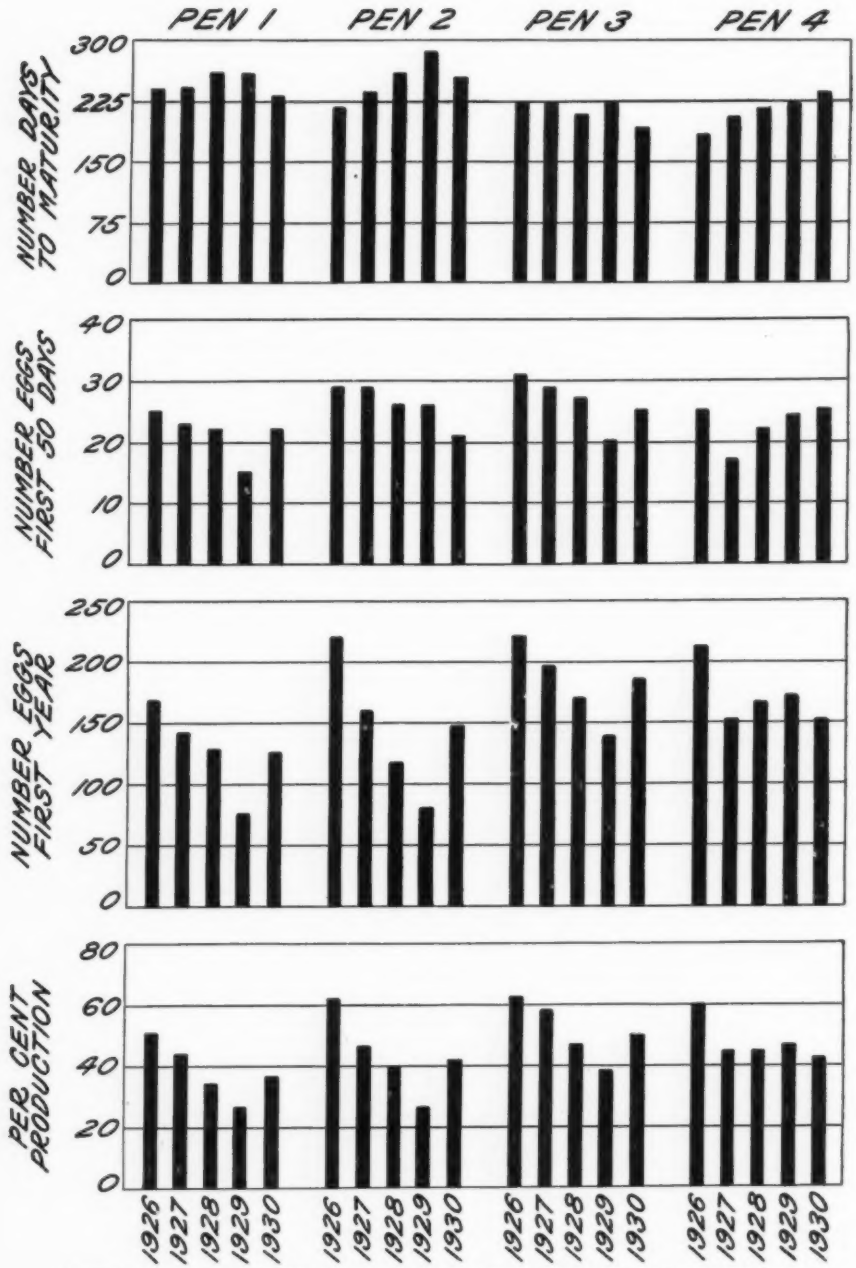
In three years of full-brother×full-sister matings in White Leghorns Dunn[6] observed a progressive decrease in hatchability as inbreeding was continued, the basis of selecting the full-brothers and full-sisters being the greatest number of full-sisters available for mating on February the first of the pullet years. In four other lines of full-brother×full-sister matings carried on, Dunn[8] observed a very marked decline in hatchability in all four lines. In one line the hatchability had decreased to 19.1 per cent in the third year of inbreeding and in another line hatchability had decreased to 18.2 per cent in the fourth year of inbreeding.

Jull[12] observed that full-brother× full-sister and half-brother×half-sister matings in Barred Pymouth Rocks and White Leghorns resulted in decreased hatchability as compared with the parental matings of unrelated stock. It was also found that hatchability decreased during the three years that the inbreeding was continued. Additional evidence concerning the decrease in hatchability under similarly close inbreeding was given in the same paper in the case of the inbred progeny secured from reciprocal crosses of Buff× White Plymouth Rocks and Partridge× Silver Penciled Plymouth Rocks. The full-brothers and full-sisters and half-brothers and half-sisters saved for mating purposes each year were selected from the largest families produced the previous year. Jull observed that the decrease in hatchability that occurred under such close inbreeding was due largely to an increase in embryo mortality during the last three days of the incubation period.

Jull[13] also observed, in the case of Barred Plymouth Rocks and White Leghorns, that hatchability decreased as the coefficient of inbreeding increased, the greatest relative decrease in hatchability occurring between the coefficients of inbreeding of 0 and 12.50. The coefficients of inbreeding were determined by the formula developed by Wright.[17] It was pointed out that continuous full-brother × full-sister matings had a more deleterious effect on hatchability than the same kind of matings alternated with half-brother × half-sisters matings.

The effects on hatchability of different degrees of inbreeding in the case of Leghorns have been given by Dumon,[4] eight males each having been mated to unrelated females, distantly related females, and closely related females. In every case except one, the per cent hatchability of the females not related to the males was higher than in the case of the females distantly related to the males, and in every case the per cent hatchability of the females distantly related to the males was higher than in the case of the females closely related to the males.

The effects on hatchability of three different forms of inbreeding have been reported by Dunkerly[5] in experiments with White Wyandottes, Rhode Island



EFFECTS OF INBREEDING AND CROSSING ON EGG PRODUCTION

Figure 4

The graphs summarize the results on the characters indicated of full brother × full sister matings, and of half-brother × half-sister matings for three years, and of crossing in the third year inbred pairs.

Reds, and White Leghorns. The three different forms of inbreeding employed were: (1), a male was mated to daughters whose ancestors were outbred; (2), a male was mated to daughters derived from a brother × sister mating; (3), a brother × sister mating. The general results secured from the three forms of inbreeding show that hatchability was lower in nearly every case than in control matings of unrelated stock and that the more closely the birds were inbred the greater was the decrease in hatchability.

From the standpoint of the effects of inbreeding on the viability of chicks hatched, the results secured by Dunn,[6] Dumon[4] and Dunkerly[5] all show that close inbreeding tends to increase chick mortality.

A decrease in egg production under such close inbreeding as brother × sister mating has been observed by Dunn[6] in the case of White Leghorns, Hays[10] in the case of Rhode Island Reds, and Goodale[9] in the case of White Leghorns. All three investigators observed that age at which laying commenced was retarded under inbreeding, a result which Dunkerly[5] also observed under the three forms of inbreeding he practised in the case of White Wyandottes, Rhode Island Reds, and White Leghorns. Wriedt[16] after six years of inbreeding following an original mating of one cock and one hen obtained 24 pullets that laid an average of 212 eggs each. Apparently, however, Wriedt did not practise close inbreeding during the last few years of his project and, moreover, these 24 pullets represented a selected group rather than all of the descendants of the original pair with which the inbreeding project was started.

The fact that the intercrossing of closely inbred lines results in an increase in hatchability has been demonstrated by Dunn,[8] Hays,[11] Dumon[4] and Jull.[14] Dunn[8] also showed that the intercrossing of inbred lines resulted in a decrease in chick mortality over that of the inbred parents.

Additional Evidence on the Effects of Close Inbreeding and on the Intercrossing of Closely Inbred Lines

The results secured by Jull[12,13,14] in inbreeding White Leghorns, Barred Plymouth Rocks, and four other varieties of Plymouth Rocks have already been referred to concerning hatchability. Additional evidence is made available here on the effects on various other characters of the close inbreeding and the intercrossing of the closely inbred lines in White Leghorns. In order that a complete picture may be presented concerning the general effects of inbreeding and intercrossing the inbred lines, the tables and graphs accompanying this article deal with all characters studied, including hatchability.

In the spring of 1925 four pens of White Leghorns, approximately 11 pullets per pen, were each mated to an unrelated cockerel. When the progeny of each of these 1925 matings reached maturity in the fall of the year, five full-sisters and at least two full-brothers were selected from the female parent in each pen that had the largest number of progeny at the time of selection. In addition, three full-sisters were selected from each of two other female parents in each pen having the next highest number of progeny at the time of selection. The five full-sisters and the two groups each of three half-sisters were mated to a full-brother of the five full-sisters. Therefore, at the commencement of each year's inbreeding work each inbred pen contained five full-sisters and six half-sisters. Such close inbreeding was carried on for three years in succession and then the progeny of the third-year inbred pens were intercrossed by mating a male from the first pen with the females from the second pen, a male from the second pen with the females from the first pen, a male from the third pen with the females from the fourth pen, and a male from the fourth pen with the females from the third pen.

The incubation period each year was

from March seventeenth to April thirtieth, the same incubator being used and similar conditions of incubation prevailing from year to year. . The chicks were brooded under as nearly identical conditions of brooding as was possible to maintain from year to year. The laying stock each year was given as nearly identical conditions of management as was possible to maintain.

The results secured dealing with characters associated with reproduction are given in Table 1 and are shown in graphic form in Figure 3, and the results secured dealing with characters associated with egg production are giv- in Table II and are shown in graphic form in Figure 4.

Concerning the effects of inbreeding on fertility, it is apparent that fertility was not materially affected during the three years of inbreeding but when the progeny of the third-year inbred pens were intercrossed fertility was lower in all four of the pens than in the third-year inbred pens. This result was quite unexpected and cannot be accounted for at present except possibly on the basis of the physiological incompatability of some of the reproductive cells of highly inbred birds in completing the process of fertilization when strains of such highly inbred birds are crossed. The possibility of such a condition existing is suggested by the results which Dunn[7] secured in alternate matings of an inbred White Leghorn male and a Rose Comb Hamburg male with inbred White Leghorn females that were full-sisters of the White Leghorn male. It is possible, of course, that some of the incubated eggs secured from the intercrossed inbred pens were fertile but were recorded as being infertile due to the early death of the embryo. If such were the case, then it is difficult to understand why the balance of the fertile eggs should have hatched better than in the case of the third-year inbred pens, as pointed out subsequently.

There was a general tendency for hatchability to decrease as inbreeding was continued in spite of the method of selecting the birds for the inbreeding matings, the selection of the breeders being based upon size of family, which meant that the birds used in the inbreeding work were selected from dams that gave the best results in hatchability. The immediate effect of such close inbreeding as brother × sister mating is a marked decline in hatchability followed by progressive decrease as such close inbreeding is continued. The results also show that the pens differed in respect to the degree of decline in hatchability. It seems certain that a very important factor affecting the viability of the embryo is its genetic constitution. Inbreeding apparently produces embryos having lethal and sublethal genes in a homozygous condition, as a result of which the embryos either die in the early stages of development or fail to hatch.

The intercrossing of the progeny of the third-year inbred pens resulted in an increase in hatchability in the case of all four pens over the hatchability of the third-year inbred pens. The intercrossing of the inbred lines apparently brought together complementary genes. The embryos produced by intercrossing inbred birds are heterozygous for more genes than any of the inbred parents, the heterozygous condition of the embryos resulting from the intercrossing of highly inbred parents gives rise to increased hatchability.

The data given in Table I and shown graphically in Figure 3 concerning the number of chicks living at four weeks of age as a percentage of the fertile eggs give information concerning the cumulative effects of the hatchability of eggs and mortality of chicks.

The index of the viability of chicks secured from the four pens each year was the per cent of chicks in each family that were alive at the end of four weeks. This period was used because it has been found, over a period of years, in the case of thousands of families of chicks reared annually at the U. S. Animal Husbandry Experiment Farm, Beltsville, Md., that practically all of the so-called "normal mortality" that occurs in the rearing of

chicks on range is accounted for during the first four weeks. The results secured in this experiment show that such close inbreeding as brother × sister mating did not affect the viability of chicks to any marked extent except that in the third year of inbreeding in pens 1, 2, and 4 there was greater mortality than in the second year of inbreeding. On the other hand, there was less mortality of chicks in pens 2, 3, and 4 in the third year of inbreeding than in the chicks of the original outbred matings.

The intercrossing of the progeny of the third-year inbred pens resulted in less mortality in the chicks of pens 1, 2, and 4 than in the chicks of the third-year inbred pens. In the case of pen 3 the mortality in the chicks secured from intercrossing was only slightly greater than in the third-year inbred mating. Moreover, in the case of all four pens, the mortality in chicks secured from the intercrossing of the third-year inbred pens was less than in the chicks secured from the original outbred matings. It should be noted that for the most part the chick mortality in these four inbred pens was considerably less than in the case of the results secured in inbreeding by the various investigators referred to in the fore part of this paper. It is apparent, therefore, that the effects of inbreeding on the viability of chicks depend to a great extent upon the kind of stock used in the original matings and the method of selecting the breeders each year of inbreeding.

Concerning the effects on egg production of such close inbreeding as brother × sister mating, the data given in Table II and the results shown graphically in Figure 4 indicate that first-year egg production decreased as inbreeding was continued in the case of pens 1, 2 and 3 but that in pen 4 egg production increased slightly although it was considerably less each of the three years of inbreeding than the egg production of the original outbred pen.

The data given in Table II and shown graphically in Figure 4 concerning per cent production represent the percentage of eggs laid during 365 days from the time that each pullet commenced laying. In all four pens the percentage of eggs laid was considerably lower in the first-year inbred pens than in the parental outbred pens. During the three years of inbreeding the percentage of eggs laid decreased each year in pens 1, 2 and 3 but increased slightly each year in pen 4. Intercrossing the inbred pens resulted in an increase in the percentage of eggs laid over the third-year and second-year inbred pens in the case of pens 1, 2, and 3.

The results secured show that the decrease in egg production under inbreeding may be largely accounted for by an increase in the number of days before the birds reach sexual maturity or commence to lay and a decrease in the rate of production, as indicated by the number of eggs laid during the first 50 days from the time that laying commences in the case of each bird.

The intercrossing of the progeny of the third-year inbred pens resulted in a marked increase in egg production in the case of pens 1, 2, and 3 over the egg production of the third-year inbred pens and in the case of pens 2 and 3 over the egg production of the second-year inbred pens. Except in the case of pen 4, age in days that laying commenced was reduced in the intercrossed birds as compared with the third-year inbred birds and except in the case of pen 2 the rate of egg production was increased in the intercrossed birds as compared with the third-year inbred birds. Research work on the inheritance of egg production has demonstrated the fact that age in days at which laying commences and rate of production are intimately associated with total first-year production and that both are inherited.

Inbreeding apparently results in an increase in the homozygous condition of genes having a deleterious effect on rate of sexual maturity, on rate of egg production, and possibly on other charcaters associated with egg production. Upon being crossed, each inbred line

is likely to furnish many of the allelomorphic genes absent in the other inbred line so that egg production is increased.

The effects of inbreeding on egg production are of particular importance to poultry breeders because they often wish to know if the mating of closely related males and females secured from their best layers will tend to produce uniformly high egg producers. The results of this experiment show that under such close inbreeding as brother × sister mating egg production is likely to decrease and the longer that inbreeding is continued the greater is the decrease in egg production liable to be. Moreover, hatchability is also likely to decrease under close inbreeding. Particular attention should be called to the fact that the effects of the intercrossing of the progeny of the third-year inbred pens have been compared with the effects of inbreeding for three years whereas if it had been possible to compare the effects of the intercrossing the progeny of the third-year inbred pens with the effects of inbreeding for four years the differences would undoubtedly have been more striking. From the practical standpoint, it is apparent that such close inbreeding as brother × sister matings can not be recommended as a system of breeding to be adopted by the poultry breeder.

Conclusions

A. Under such close inbreeding as brother × sister matings for three years, the following more important results have been secured:

1. Fertility of eggs was not materially affected.
2. Hatchability of eggs decreased, the greatest relative decrease occurring in the first year of inbreeding.
3. Viability of chicks was not materially affected.
4. Age in days that laying commenced increased under inbreeding.
5. Rate of egg production, as determined by the number of eggs laid the first 50 days after laying commenced, decreased, for the most part.
6. Total first-year egg production decreased.

B. The intercrossing of the progeny of the third-year inbred pens gave the following results as compared with those secured from the third-year inbred matings:

1. Fertility, for the most part, decreased.
2. Hatchability increased.
3. Viability of chicks increased.
4. Age in days that laying commenced, for the most part, decreased.
5. Rate of egg production, for the most part, increased.
6. Total first-year egg production, for the most part, increased considerably.

Literature Cited

1. Cole, L. J. 1932. Personal communication.
2. Cole, L. J. and J. G. Halpin, 1916. Preliminary report of an experiment on close inbreeding in fowls. *Jour. Amer. Assn. Inst. Invest. Poul. Husb.*, Vol 3, pp. 7-8.
3. ————, 1922. Results of eight years of inbreeding Rhode Island Reds. Abstract *Anat. Rec.*, Vol. 23, p. 97.
4. Dumon, A. G. 1930. The effects of inbreeding on hatchability. *Proc. Fourth World's Poul. Congress*, pp. 1-5. Published by His Majesty's Stationery Office, London, England.
5. Dunkerly, J. S. 1930. The effect of inbreeding. *Proc. Fourth World's Poul. Congress*, pp. 46-72. Published by His Majesty's Stationery Office, London, Eng.
6. Dunn, L. C. 1923. Experiments on close inbreeding in fowls. A preliminary report. *Storrs Agr. Exp. Sta. Bul.* 111, pp. 138-172.
7. 1927. Selective fertilization in fowls. *Poul. Sci.* Vol. 6, pp. 201-214.
8. ————, 1928. The effect of inbreeding and crossbreeding on fowls. Suppl. I der *Zeit für ind. Abst.-und Vererb*, pp. 609-617.
9. Goodale, H. D. 1927. Six consecutive generations of brother to sister matings in White Leghorns. A preliminary report on studies in inbreeding in poultry. *Poul. Sci.* Vol. 6, pp. 274-276.
10. Hays, F. A. 1924. Inbreeding the Rhode Island Red fowl with special reference to winter egg production. *Amer. Nat.*, Vol. LVIII, pp. 43-59.
11. ————, 1929. Inbreeding in relation to egg production, *Mass. Agr. Exp. Sta. Bull.* 258, pp. 256-302.
12. Jull, Morley A., 1929. Studies in hatchability. II. Hatchability in relation to the consanguinity of the breeding stock. *Poul. Sci.* Vol. 8, pp. 219-229.

13. ————. 1929. Studies in hatchability III. Hatchability in relation to the coefficients of inbreeding. *Poul. Sci.* Vol. 8, pp. 361-368.

14. ————. 1930. Studies in hatchability. IV. The effect of intercrossing inbred strains of chickens on fertility and hatchability. *Poul. Sci.* Vol. 9, pp. 149-156.

15. PEARL, RAYMOND. 1913. The measurement of the intensity of inbreeding. *Maine Agr. Exp. Sta. Bull.* 215, pp. 123-138.

16. WRIEDT, CHR. 1927. Die Grundlagen für eine rationelle Zuchtauswahl bei Hühnern. *Archiv. f. Geflügelkunde,* Vol. 1, pp. 293-312.

17. WRIGHT, S. 1923. Mendelian analysis of the Pure Breeds of Livestock. *Journal of Heredity* 14: p. 339.

TABLE I.—The results secured from full-brother × full-sister and half-brother × half-sister matings, for three years and from intercossing the third year inbred pens on characters associated with reproduction in white leghorns.

Pen	Year	Nature of mating	Number of eggs set	Per cent fertility	Per cent fertile eggs hatched	Number of chicks hatched	Chicks living at 4 weeks per cent of fertile eggs	Chicks living at 4 weeks as per cent chicks hatched
1	1925	Outbred	284	83.8	79.9	190	64.7	80.2
	1926	F_1 inbred	249	96.9	82.8	120	48.5	70.6
	1927	F_2 "	299	86.6	44.0	107	40.5	86.1
	1928	F_3 "	109*	97.0	80.7	84*	43.3	77.0
	1929	Intercrossed	173	84.9	57.6	87	36.2	89.4
2	1925	Outbred	273	97.5	81.8	218	62.9	77.5
	1926	F_1 inbred	297	98.2	46.0	256	59.5	90.1
	1927	F_2 "	333	97.3	54.8	137	49.0	92.0
	1928	F_3 "	289	93.9	49.9	134	42.1	82.8
	1929	Intercrossed	314	71.3	57.5	210	54.9	95.8
3	1925	Outbred	286	95.4	75.0	204	68.9	92.2
	1926	F_1 inbred	362	98.9	49.6	176	46.0	90.2
	1927	F_2 "	347	91.8	57.8	188	55.6	96.5
	1928	F_3 "	334	96.2	55.8	176	52.8	94.6
	1929	Intercrossed	411	84.1	62.7	224	60.2	95.3
4	1925	Outbred	290	95.0	87.8	252	88.8	87.3
	1926	F_1 inbred	401	90.9	66.3	299	54.1	90.3
	1927	F_2 "	237	88.1	54.0	116	50.7	90.8
	1928	F_3 "	316	89.7	33.7	68	26.3	79.9
	1929	Intercrossed	345	79.5	50.9	99	47.4	94.5

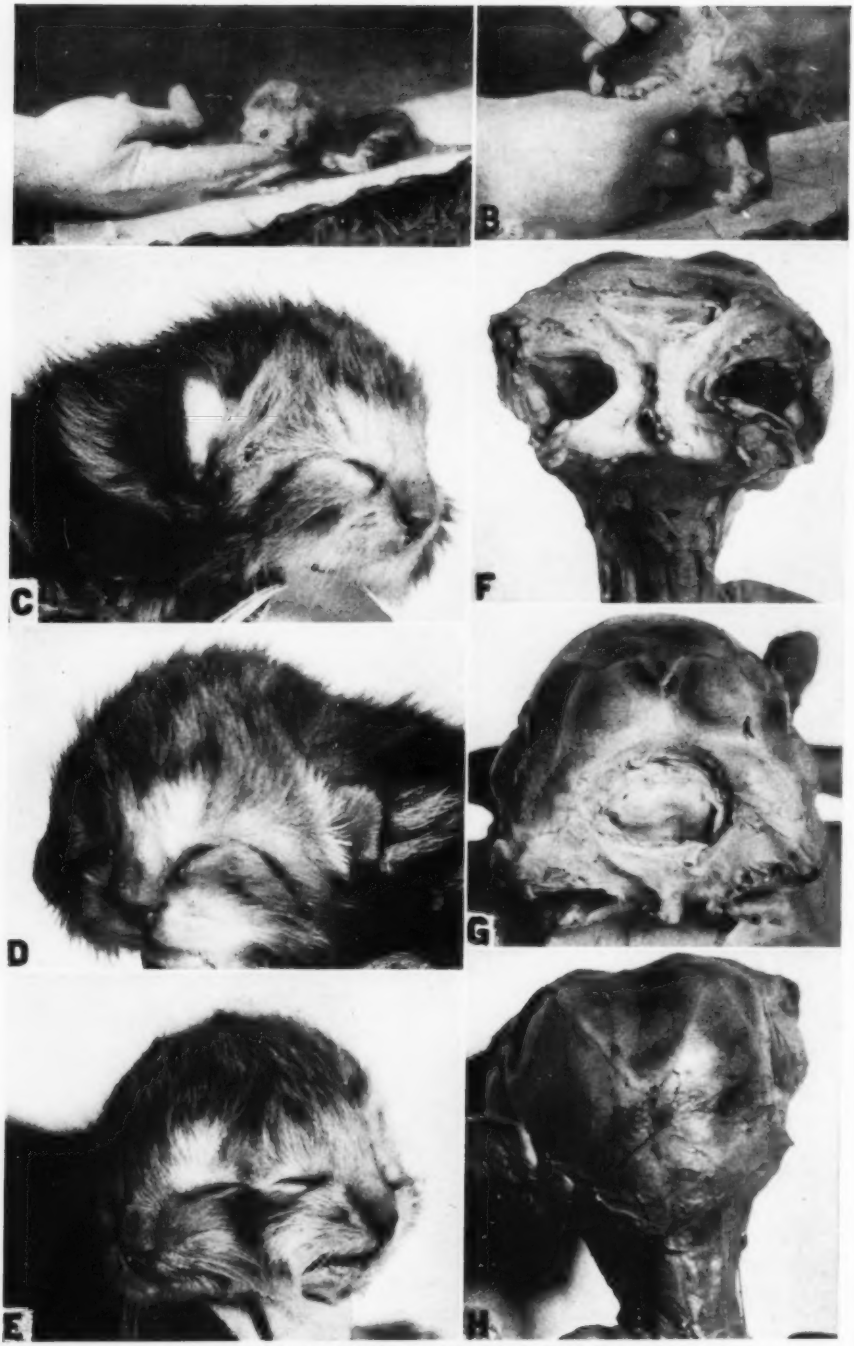
* Six birds were stolen from this pen just prior to the breeding season.

TABLE II.—The results secured from full-brother × full-sister and half-brother × half-sister matings for three years and from intercrossing the third year inbred pens on characters associated with egg production in white leghorns.

Pen	Year	Nature of mating	Average number days living increased	Average number eggs first 56 days	Average number egg first year	Per cent production
1	1926	Outbred	238	25	168	80.8
	1927	F_1 inbred	240	23	143	64.2
	1928	F_2 "	243	29	129	58.3
	1929	F_3 "	261	18	76	38.6
	1930	Intercrossed	291	30	126	56.2
2	1926	Outbred	217	29	219	62.0
	1927	F_1 inbred	234	29	153	44.4
	1928	F_2 "	265	26	119	46.2
	1929	F_3 "	268	26	89	36.3
	1930	Intercrossed	297	21	147	41.9
3	1926	Outbred	223	31	220	62.2
	1927	F_1 inbred	238	29	197	58.5
	1928	F_2 "	237	27	178	49.6
	1929	F_3 "	228	20	139	34.0
	1930	Intercrossed	191	25	188	80.4
4	1926	Outbred	182	25	213	80.4
	1927	F_1 inbred	205	17	180	65.3
	1928	F_2 "	218	22	161	44.9
	1929	F_3 "	221	24	178	47.4
	1930	Intercrossed	194	25	181	43.0

Semi-Featherless Poultry

In *Nature,* (London) May 21, 1932, Volume 129, Page 762, Ruth Bamber Bisbee reports an inherited condition in Rhode Island Reds. In this strain, chicks showing various degrees of lack of feathers are produced by apparently normal individuals. The more abnormal chicks do not reach maturity. Mating the surviving featherless stock to normal individuals produces abnormal offspring, and back mating among the abnormals also produces every degree of abnormality. Nutritional deficiencies are ruled out, but the abnormality suggests iodine deficiency. It is therefore considered possible that the thyroid gland is involved. The mode of inheritance is not established.



VIEWS OF THE TWO-FACED KITTEN

Figure 5

For description see opposite page.

A TWO-FACED KITTEN

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A TWO-FACED KITTEN

Figure 6

THE kitten here described was born on April 22, 1931, at the home of John Jansen, West Hartford, Connecticut. It was the fourth and last kitten of a litter from a common tiger gray cat. It was tiger gray and female (Figure 5 *A, B*). A preliminary description of its external features and those made plain on skinning it is given below and a fuller account of the anatomy as revealed by dissection and section will be reported later when the study is complete.

As shown by the accompanying fig-

LEGEND OF FIGURE 5

A—Photograph of two-faced kitten with the writer's hand, taken third day after birth. *B*—Same as *A*, in different position. *C*—Side view of two-faced kitten, taken from the right side, to show the one ear of the pair. *D*—View of the kitten from the left side and partly from in front, to show the other ear and doubling of the face. *E*—Front view of the double face showing the four eyes, two noses, and two mouths. *F*—Ventral view of the skinned head and neck to show the two mouths, single neck, and single large orbit occupied by two eyes between the two noses. *G*—Anterior view of the head after skinning, to show sutures of the skull, double orbit, and general doubling of the fore part of the skull and upper jaws. *H*—Dorsal aspect of the skinned skull to show the sutures of the skull and the region at which doubling begins. One ear was removed with the skin, the other remains.

ures from photographs, there was a single head, one pair of ears, two complete faces, with two mouths, two noses properly formed, and four eyes, two of which were situated in a common orbit between the two noses, but had completely separate slits and eyelids (Figure 5 *C, D, E*).

The kitten was seen alive by the writer three days after its birth, when the photographs for Figure 5 *A* and *B* were taken. Members of the Jansen family reported that it suckled successfully, using the left mouth. At that time it was apparently surviving pretty well the tremendous amount of handling to which it was being subjected by numerous visitors who went to see it. It died, however, the second night following, probably from lack of rest and the constant handling.

The body was brought to the laboratory about 12-18 hours after death and an attempt was made to inject the blood system. This proved impossible with the rather clumsy equipment used. The animal was photographed again for Figures 5 *C, D, E,* and 6. It was skinned and the body cavities opened and the whole immersed in Bouin's fluid for rapid and complete preservation.

Opening the body cavities revealed that there was one stomach with curdled milk in it. The thoracic and abdominal contents were apparently normal. So were the circulations to the fore and hind limbs.

After fixation in Bouin's for some days and hardening and dehydration in 50 and 70 per cent alcohols, the skinned head and neck were photographed from different aspects as shown in Figure 5 *F, G,* and *H*. These bring out the skull sutures very well from front, crown and occipital aspects.

The skull is double from the parietals forward, single from that region posteriorly.

Dissection of the muscles and nerves of the head and face regions has not yet been made nor has the investigation of the brain conditions been undertaken. It seemed worth while to report the case with the details already known at this time. Others more or less like this one must occur and comparative studies made of a series should throw light on the fundamentals of the processes of such partial twinning. The extent of duplication of nerves, muscles, and blood vessels and particularly that of the central nervous system will be gone into when time can be found.

The superficial examination, so far possible, indicates a single medulla oblongata, with proper nerves; a single cerebellum, probably somewhat enlarged; and double, more or less complete cerebral hemispheres and midbrain, with eyes symmetrically related to the doubled parts. One is not yet able to say with certainty whether or not the two eyes in the one centrally placed orbit are completely separate and perfect.

A New Method of Sex Prediction

SEX prediction and sex determination are two quite different things, which are sometimes confused. A report in the *Journal* of the American Medical Association for November 12, 1932, outlines a method of sex prediction that has been some 90% correct in a series of 80 cases. It is effective from sixth month of pregnancy to the time of birth.

The method is based on the effect produced by injecting urine from pregnant women into immature male rabbits. The predictions are based on the effect of these injections on the testicular tissue of these rabbits. Precocious development of testicular tissue within 48 hours indicates a female child; normal rate of development, a male. In two cases where a boy was predicted heterosexual twins appeared. The technique may have some practical medico-legal applications and would appear to be of interest in connection with hormonal influences in sex differentiation.

PIGS BORN WITHOUT EYE BALLS

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A LITTER OF EYELESS PIGS
Figure 7

Progeny of normal Duroc-Jersey sow all showing complete absence of eye balls. Since both the parents were normal-eyed it is practically certain that this defect is not hereditary. It is rather to be taken as an example of the profound effect that vitamine deficiency may have upon development.

A REGISTERED Duroc-Jersey gilt receiving a ration deficient in Vitamin *A* at the Texas Agricultural Experiment Station, farrowed on March 29, 1932, eleven pigs, all of which were born without eye balls. Ten of the pigs were alive at birth, one lived four days, one lived three hours, while the others died within five minutes after birth. The gestation period for the litter was 111 days, and their average birth weight before nursing was 1 pound 14 ounces. This gilt was placed on the vitamin *A* deficient ra-

tion when four months of age, and was bred 160 days later. She was kept in a pen with a concrete floor, and was fed in a self-feeder. Thirty days after being bred, she became too weak to get up. Cod liver oil was then supplied in daily doses of two ounces for 20 consecutive days. The gilt gained enough strength to move about the pen and eat regularly five days after she was started on the cod liver oil. After 20 days, the cod liver oil was given every other day for one week, after which it was discontinued, as the gilt appeared to be strong and had a good appetite. Forty-six ounces of cod liver oil were given in all. The litter of pigs was farrowed 53 days after discontinuing the cod liver oil.

Hereditary eye defects have been noted in rabbits by Guyer,* and there is also an "eyeless" recessive character in Drosophila, but a litter of eyeless pigs has not previously been noted.

Since both the sire and dam of this litter of pigs had normal eyes, this defect, if hereditary, would have to be the result of a recessive factor, and in which case both sire and dam must have been heterozygous.

Assuming that both sire and dam were heterozygous for a single factor, the chance that all of the eleven pigs in the litter would be homozygous recessive for this character are only one in approximately four million.

Further evidence that this defect is not hereditary is furnished by one litter of eleven and one litter of eight pigs with normal eyes, sired by the same boar but farrowed by different sows.

While the cause of this abnormality has not been fully determined, and the study is being continued, evidence points to a vitamin *A* deficiency as the causal factor. The condition is illustrative of the marked effect that a deficiency may have in the disturbance of the internal factors that control the mechanism of development.

*Guyer, M. F. 1924) "Further Studies on Inheritance of Eye Defects Induced in Rabbits," *Jour. Exp. Zool.*, 38:449-474.

Sickle-Celled Anemia in the White Race

Rosenfield and Pincus [in *Amer. Journal of Med. Sci.*] state that a review of the literature of sickle cell anemia in the white race reveals only one previous case in which no evidence of a possible admixture of Negro blood can be discovered. A second case is cited in which the data are incomplete for such a conclusion. The authors report a third case in a family in which three generations show the sickling trait and at least five generations are known to be of the white race from a region where Negroes are practically unknown. The ethnologic and clinical features of the subject are discussed by the authors. They conclude that in the future more cases of sickle cell anemia in white persons will be discovered. The reasons for this statement are as follows: First, since attention has been called to the occurrence of the sickling trait in the white race, more frequent examinations of the blood for sickle cells will be made, especially in those patients presenting the syndrome of an atypical hemolytic icterus. Thus, more cases of the type described by the authors may be discovered. Second, since it is known that the sickling trait is a dominant character in its hereditary transmission and since interbreeding between the Negro and the white races is more or less constantly taking place in many regions, including this country, one may in the future generations expect the presence of this peculiar blood trait in an increasing number of apparently white descendants. Because of the tendency to deny such descent, no history will be obtained of such racial origin in affected individuals, thereby increasng the number of apparently pure white cases of sickle cell anemia.

Journal Amer. Med. Asso., Feb. 4, 1933.

A LIVESTOCK SCALING INSTRUMENT

A Memoir Introducing a Method for the Quantitative Evaluation of Type in Animals

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A DOMESTICATED animal has two economic functions—production and reproduction.

Its individual productivity is indicated by the quantity of butter fat, lard, lean meat, milk, wool or meat it can produce on a given ration in a given time.

Its ability to reproduce relatively few or many offspring in proportion to available breeding opportunities can also be measured quantitatively. But there is still one important desideratum to be determined before an animal's reproductive worth can be appreciated and that is, the relative excellence of the type of its progeny when compared with breed standards.

The Babcock and feed lot tests lend themselves splendidly to such methods of evaluating both parent and progeny and admit of correlation. For cattle whose productive value is greater than their reproductive value, these measures are admirable, but in pedigreed animals it is essential that breed standards of type be maintained and as yet no method has been evolved by which conformation can be satisfactorily expressed numerically.

There are very many instances in which experimenters have, by use of direct measurement, attempted to evaluate and classify the type of animals, but every such system has been found to have defects. It is thought that earlier attempts at skeletal measurements had relied for description too largely upon detail and not sufficiently upon those major characteristics which are indicative of an animal's form.

In stock shows the judge is not dependent upon actual body measurements. His practiced eye determines such groupings of anatomical parts as make for breed type and symmetry and he is quick to detect any unbalanced development. The artist finds it possible to reproduce faithfully on canvas the curves and angles of an animal. Both these experts unknowingly use the same principle; they project as a straight line curves which, if expressed in terms of circumference or radii, would have little or no meaning except as essential units of a harmonious grouping of which a whole appreciation is lost as soon as any one part is too completely separated from its relationships.

There is a balance to all symmetry of form. Component parts are interrelated and the proportion of one to another gives the best indication of the whole. The estimation of such relationships as ratios is not new in animal husbandry.

Ritzman at New Hampshire, working with cross bred sheep, expressed his results thus. The data had been determined by direct measurements upon the animals and he was able to show that the ratios so obtained seem to indicate characteristic particulate Mendelian inheritance.

Wriedt analysing the New Hampshire results was quite definite in stating that the narrow chest of Rambouillet was dominant over the wider Southdown thoracic cavity. His conclusions were probably hastily drawn, but the illustration of his point in the text where the two types of cavity are shown in cross section, indicates that it was the ratio of width to depth that he was considering rather than an exact measurement.

It is not, however, the relative mer-

its of strict skeletal measurements over ratios which is here being considered, but rather a method of determining such ratios. An instrument was devised in Australia by which the animal could be, as it were, surveyed.

Dr. A. E. Brandt of the Iowa State Agricultural College made the reproduced workable instrument* from a cardboard model prepared by the author and with it this study was made.

The author desires to express his appreciation for this cooperation, which is characteristic of all the American institutions it has been his privilege to visit.

The method is such that animals are surveyed to quantitatively estimate their type. The data so obtained are treated statistically in such a way that the excellence of the animal's type is evaluated.

The whole is a system of indirect measurement of skeletal proportions which permits the correlation of type, production records and the heredity of the animal under consideration.

Suitable skeletal measurements from which to prepare indices were chosen. In this selection the criterion was that the measurements should be, insofar as is possible, essential for the appreciation of the type of the animal, that they should be little affected by environment, and that they should be such that when any two were compared to give a ratio, the index should have a real meaning to a stockman reading the final analysis of the results. Thus, for example, the ratio of height to heart girth was chosen in preference to that of height to any other measurement which a livestock judge would be unlikely to use involuntarily in association with height.

The method, though worked on in Australia, was not developed further than a semi-experimental stage comparable to the results tabulated herewith. To introduce the method to America a study was made of the Holstein cows of the Iowa State College. Indices were also prepared from a survey of the standard model of the Holstein Breed Society and these were compared with those of the animals.

It is worthy of note that though

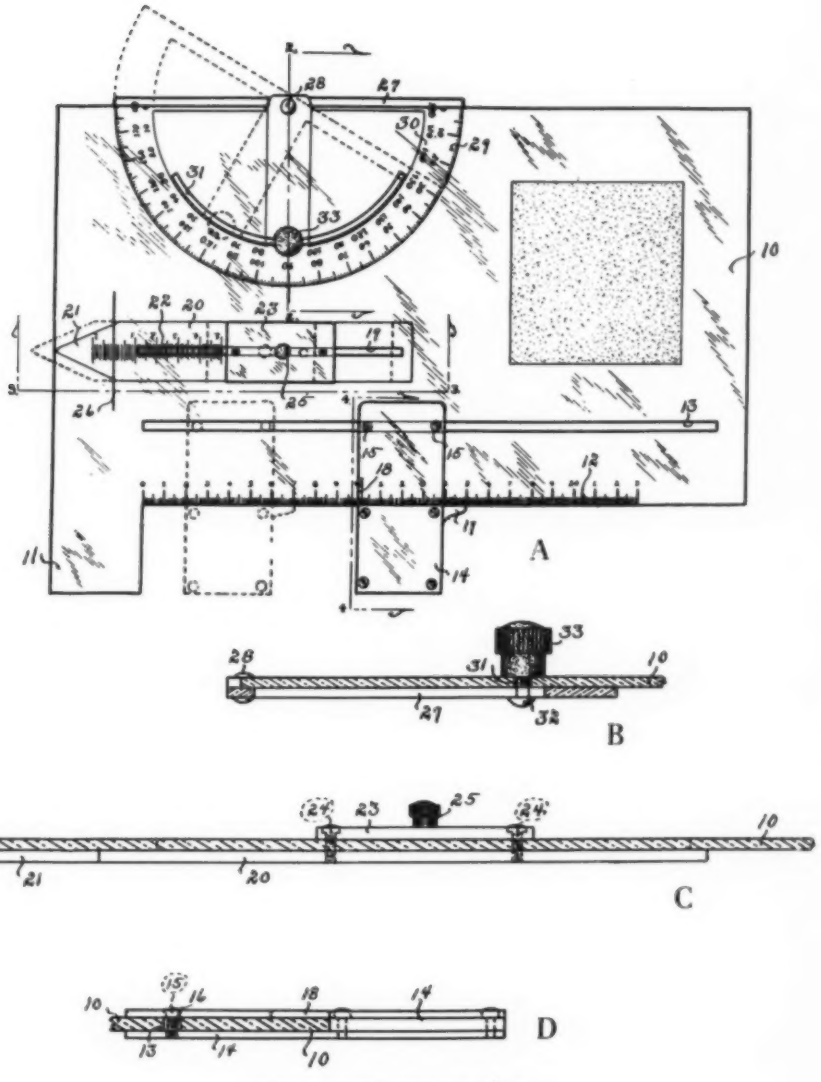
*The details of operating this instrument are given in the patent specification, from which the following is an excerpt:

"As all of the main parts of the instrument are of transparent material such as celluloid or the like, one may easily see the object or objects to be measured through the instrument, thereby facilitating the movement of the movable scale portions. In the actual use of the instrument the same is held a predetermined distance from the eyes and the parts sighted or adjusted onto the object. All measurements of height or length are obtained on scale 12. The reading is obtained by adjusting the member 14 to a position where that member and the member 11 bracket the object to be so measured. As we have before seen, the bevel portion 18 is the portion of the member 14 that reads on the scale 12.

"The drawings show the base member 10 in one position but in measuring the various portions of an object such as an animal, the base 10 may be turned or rotated to any desired position. This is especially necessary in the using of the scale 22 and the protractor 27. The scale 22 is used for measuring any concave or convex curvatures. To accomplish such a reading, the slidably mounted member 22 is moved forwardly or downwardly, as the case may be, until the point 21 contacts the depression or projection of the subject. During such reading it will be evident that the left marginal edge of the base 10 is sighted on the subject at each side of the depression or projection being measured. The scale 22 which is on the slidable member 20 reads on the fixed line 26, thereby giving negative or positive readings.

"The protractor is particularly adapted to the measuring of skeletal structures or like, showing actual or imaginary angular departures from a straight line. When using the protractor, the nut 33 should be loosened and thereafter acts as a handle member to facilitate the rotation of the protractor.

"After the protractor has been correctly placed and sighted onto the object to be measured, the nut 33 may be tightened, thereby rigidly holding the protractor in the desired position until further used. When using the protractor, the upper marginal edge of the base 10 is used to obtain the readings which may be either negative or positive on the protractor."



THE LIVESTOCK-SCALER

Figure 8

Patent drawing, modified, showing plan and details of construction of scaling device. *A*—is a front view of the complete instrument ready for use. *B*—is a side view of the protractor portion of the instrument and is taken on Line 2—2 of Fig. *A*. The protractor is used for measuring angles such as slope of shoulder. *C*—is a cross sectional view taken on Line 3—3 of Fig. *A*, to more fully illustrate the slidable portion used for measuring the convexity or concavity of outlines such as arch of back. *D*—is a sectional view taken on Line 4—4 of Fig. *A* and more fully illustrates the sliding scale portion. This sliding scale is used for securing the linear measurements from which the various indices are calculated.

Professor Hansen of the State College was using the instrument for the first time, indices prepared from his readings of observations on the ideal Holstein bull and cow models, differed only .087 from those prepared from the author's own observations independently taken. This is shown in the accuracy of method table. The data herewith are too fragmentary to do more than indicate the method and its accuracy, and to suggest its possible application to livestock activities.

Relatively little time is taken in making the survey of a beast. Professor Hansen and I without assistance caught, haltered, surveyed, and recorded the observations on eight cows in 50 minutes without undue haste.

One can make the survey on any animal whether at pasture or under restraint, but the procedure is simplified if the beast is standing normally when haltered to a fence or the like.

For pigs it is possible to measure the arch of the back while, with the instrument, the slope of the pelvis of cattle is capable of simple estimation by two observations which will be included in a ratio; one is the angle between an imaginary line from the external angle of the illium through the tuber ischii and the projected line of the spines of the thoracic and lumbar vertebrae, and the second observation is a perpendicular dropped from the same projected line to the tuber ischii. The former gives the slope of the pelvis; the latter indicates the degree to which the sacrum follows the pelvis in its declension. Both are expressed as a ratio.

There are too few data available for analysis, but had all groups been as large as 8a, the mean, standard deviation, and coefficient of variability would have been determined for each as a test of uniformity.

The deviations of the M_I (mean of indices) of the groups from the M_I of the ideal indicate the tendency of the group to depart positively or negatively from the ideal or to conform to it.

A bull is judged on the uniformity of his get and on the close approximation of their M_I to those of the M_I of the ideal.

There are many other statistical methods which could be applied to the data. They admit of a very wide field of application to all animals, but particularly to the evaluation of type in cattle and hogs. In this connection Dr. R. A. Fisher's kindly interest and assistance have been invoked by Dr. Brandt and myself. Many methods of analysis have been discussed and one feels under no little obligation to Dr. Fisher, of Rothamsted, for his assistance.

The nature of the particular study would naturally determine the method of analysing the data. This memoir is intended to do no more than show the application of the method to the classification of bulls in advanced register of merit work as a quantitative measure of type for the analysis of progeny tests in the Holstein breed of cattle.

One is indebted to Professor Han-

TABLE I. Indices from three observations of two observers acting independently (Professor Hansen and self) and preparation of M_I (mean of indices) from Ideal Cow.

	Professor Hansen				Self			
	1	2	3	M	1	2	3	M
Barrel								
Points of shoulder	1.442	1.385	1.383	1.403	1.525	1.511	1.500	1.512
Height								
Heart girth	1.538	1.575	1.595	1.569	1.543	1.548	1.743	1.611
Length								
Body girth	1.959	2.058	2.020	2.012	1.946	2.250	2.205	2.133
Hooks								
Pins	2.100	2.000	2.200	2.100	1.916	2.105	2.000	2.007

Note: Discrepancies in indices, inter- and intra-class as indications of accuracy of method.

sen for his kindly interest and assistance in making possible the collection of these data.

Application has been made for patent rights over the instrument. These have been assigned to the President and Council of Iowa State College of Agriculture and Mechanic Arts from whom these instruments can be obtained.

EDITOR'S NOTE: Nine tables illustrating the application of the method were submitted with this article. Limitation of space forbids the inclusion of all these, interesting as they are as examples. Table I is being reproduced in full, and the table headings of the other eight tables, to hint at least some of the applications of the method.

Table Headings

2. Indices from three observations of two independent observers and preparation of M_1 for Ideal Bull.
3. Table of M_1 (mean of indices) for Ideal Holstein Bull and Cow.
4. Test for accuracy of method. Discrepancies of M_1 for three observations for each of four indices by two independent observers (96 measurements).
   MD (mean discrepancy) of indices .087.
   Note: One observer, Professor Hansen, was using the instrument for the first time.
5. Analysis of variance—Professor Hansen and self.
6. Females arranged in sire groups.
   Common sire—KPMJ
   Group a. 3 yrs.—milking and pregnant.
   Group b. 2 yrs.—pregnant, first calf in utero.
   M_1 (mean of indices) for 2 and 3 yr. olds.
7. Females arranged in sire groups.
   Common sire—AOGL
   and deviations of individuals from M_1 of Ideal Female.
8. Progeny Groups.
   8a. Single male and deviations from M_1 of Ideal Holstein Bull.
   8b. Two females and deviations from M_1 of Ideal Holstein Cow.
9. Comparisons of deviation of M_1 of two year olds and M_1 of three year olds from the M_1 of mature Ideal Cow to see if age factor makes necessary an Ideal index for each year of age.

A CASE OF SUPERFETATION IN THE WALTZING MOUSE

WM. H. GATES
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A CASE of probable double superfetation in the ewe was recently reported by C. E. Aubel.* It may, therefore, be of interest to record a case of superfetation in the Chinese mouse, *Mus bactrianus*.

The mouse was of the variety known as the Japanese Waltzing mice. This particular strain has been inbred, brother-sister, or father-daughter, since 1922. For genetic purposes, the immediate ancestry represented a mother-son mating, followed by a mother-grandson mating, and the female in question was one from a litter out of the same dam by her own great grandson.

This mouse, No. 20768, was born on February 13, 1932. The litter was weaned on March 12 and the two females were mated to a brother. No. 20768 gave birth to a litter consisting of three males and three females on April 21, 1932. This litter was raised and weaned and the mother returned to her pen on May 23.

On August 19, she was observed to be pregnant and, as is the general practice, was isolated into a clean pen. Three young were born August 23,

*AUBEL, C. E.—1932—A probable case of double superfetation in the ewe. JOURNAL HEREDITY 23: 159-160.

all of which were females and normal in size and appearance. The mother continued to nurse these until August 30, when it was quite evident that she was again pregnant. The three young were given to a foster mother and No. 20768 again isolated into a clean pen.

On September 1, she gave birth to another litter of three, one male and two females. All were normal as far as could be observed. These were left with the dam and she nursed them to weaning.

The normal gestation period in this mouse is nineteen days but, like the house mouse, *M. musculus*, this may be extended several days if the mouse is nursing. However, prolonged gestation up to thirty days probably never equals that reported for the house mouse by Daniel.*

There is little doubt that, in this case, gestation, at least for the litter born on August 23, was the normal, as the mouse had not been nursing for some time previous. It is impossible to say just what conditions prevailed in the case of the second litter. It is hardly likely that the two litters are the result of a single fertilization, since prolonged gestation in the bactrianus probably never exceeds the normal to the extent of nine days, the difference in time between the two litters. Yet the small size of each litter might indictate that there had been but a single ovulation. The average number of young in thirteen litters in the immediate ancestry of this mouse is 5.4. Among these litters there is not one with a smaller number than four. A litter of three is therefore unusual and may possibly denote a single ovulation. On the other hand, it is highly improbable that gestation would be prolonged nine days beyond the normal when there are no apparent causes for such extension of time.

The birth of these litters only nine days apart, and the complete isolation of the mouse five days before the birth of the first litter precludes the possibility of a late fertilization and premature birth. The normal size, appearance and development of the young after birth would indicate a normal gestation in both cases. This would mean copulation on August fourth for the first litter and a second copulation on August thirteenth for the second litter. The hypothesis of a single copulation and a single ovulation is hardly tenable considering the length of time between litters. There is, therefore, little doubt that this is a case of superfetation and not superfecundation.

*Daniel, J. Frank—1910—Observations on the period of gestation in white mice. *Jour. Exp. Zool.* 9: 856-870.

A Guide to Medical Genetics

EINFUEHRUNG IN DIE MENSCHLICHE ERBLICHKEITSLEHRE UND EUGENIK. *By* K. Saller. Pp. V 307. RM 24. Julius Springer, Berlin. 1932.

NO one has packed more information about heredity and eugenics into the same space than has Dr. Saller, Privatdozent for anatomy at the University of Göttingen. His book is designed particularly as a guide to research for medical students and, as he notes in the preface, is suited to those who are prepared to do some real studying, and who have the advantage of library facilities, if not also of an instructor. Many subjects are necessarily treated summarily, if not inadequately, while others are particularly well done. Among the latter may be mentioned the treatment of inherited abnormalities, with a rare series of illustrations and particular emphasis on the tendency toward a different manner of inheritance in each separate family considered. The lack of proper citations to literature is a serious handicap to the reader who wants to follow up the innumerable paths to which the author points. Because of its comprehensive nature, however, the book will be highly useful to serious students of the subjects of heredity and eugenics.

Paul Popenoe.

REVIEWS OF BOOKS

Variability of Race Crosses—The Newer Plant Breeding—Sinnott and Dunn's *Genetics* Revised—How We Grow—Genes and Mental Abnormalities—The Negro in Africa—Itis' *Mendel* in English

Measuring the American Negro

ANTHROPOMETRY OF THE AMERICAN NEGRO. *By* MELVILLE J. HERSKOVITS. Columbia University Contributions to Anthropology, vol. IX, 1930.

THIS is a very methodical and complete series of measurements of nearly one thousand adult negro males, an equivalent number of adult females and some thousands of negro children of both sexes. The measurements are accompanied by a compilation and analysis of genealogical data supplied by the measured subjects. Adequate in size, this sample of the negro population gleaned material from 34 different states and the West Indies. The largest single series was measured at Howard University.

The author begins auspiciously by measuring his own measurements and those of his assistants and collaborators. He combined, in tabular presentation of results, only those series in which measurements for the character in question were strictly comparable. Naturally unable to compare his mensural methods with those of the other authors, whose statistical constants he compares with his own, he makes no inference, from differences observed, that might be considered mensural rather than real.

Maintenance of these standards precluded the combination of either colleagues' or assistants' color top estimations of pigmentation with his own. Considering the importance of a measurement of pigmentation in anthropological research, and keeping in mind the fact that pronouncements in this field are often made with a good deal of authoritative dignity, it is surprising that anthropological methodology has not progressed beyond the use of the color top, an instrument the limitations of which Herskovits thoroughly exposes. The author found his own measurements, made at different times, quite comparable with one another.

Herskovits found that all but one of his different adult series would fit neatly into a composite homogeneous group, the American Negro. The nonconformists, gathered in the New York selected series of professional and well-to-do negroes, were taller, lighter, and narrower of lip and nose than the others. The author's presumption that their additional stature was due to a very favorable environment is not entirely convincing in view of the equally obvious dissimilarity in the other characters and the even greater stature of Todd and Lindala's "pauper selection" of negro cadavers.

The means for the different American Negro characters occupied a variable position between those of the parent races. In ear length and in width of ear, nose and lip, the American Negro is still African in type. In head length, cephalic index, facial width and height of nose, he proved to be more like the white groups with whom he was compared. Herskovits' objection to the census estimate that the American Negro population is 85% negro appears justified.

The cephalic index was found to decrease with increasing age. The amount of black pigment in the skin undergoes some minor changes and generally decreases with increasing age. Adult males have thicker lips than adult females, the lips decreasing slightly in thickness, when the adult stage is reached, in both sexes.

Variability

Comparisons of variability in different characters show the American Negro, a hybrid, to be less variable than unselected

American whites and but slightly more variable, on an average, than the unmixed white or black groups which might be considered parental types (Old Americans or West Africans). The author's inference that the racial characters dealt with are, therefore, not in any instance simple Mendelian ones, is in accord with the results of the hybridization of other mammalian races. The author considered the lack of variability unexpected although it has been established (Sumner) that even the F_2 generation produced by hybridizing geographic races of mammals which differ from one another in many of the same characters as races of men, is not much more variable than either the first hybrid generation or the parent races.

One should keep in mind, in connection with this subject, that present day American negroes are not members of an F_2 generation the parents of which have been carefully measured. They are a residual hybrid population, exact parentage unknown, which has been subjected to a heavy and probably selective death rate; a population, moreover, which appears to have suffered a continual loss—by "passing over"—of its least negroid members. These, incidently, would be the most extreme deviates on one side of the variability curves of the characters, in which negroes and whites differ. The precise status of our negro population in the question of the variability of hybrids deserves emphasis because of the tendency, on the part of the uncritical, to quote Herskovits as having proved that hybrid populations are no more variable than pure races.

Accuracy of Genealogical Data

The author made a careful analysis of that portion of the genealogical data which he had gathered at Howard University. Subjects were allocated to the classes: negro (N), more negro than white (NNW), mixed negro-white (NW), more white than negro(NWW). A similar classification was made by adding Indian to each of the above categories for subjects who claimed partial descent from the noble red man. Means and standard deviations of all the different traits were calculated for each of the genealogical classes. In the traits in which whites and negroes differ the means of the genealogical classes varied as they would be expected to if the family histories were roughly accurate. For example, the means of the percentage of black pigment on the outer upper arm were, in order of decreasing size: N, NNW, NW, NWW. The means of the comparable groups in the parallel series, with recorded admixture of Indian, were but slightly different in magnitude and similar in order. The author's inference is the guarded one that "the genealogical information is as reliable as data of this kind are usually found to be."

He naturally considers the alternative possibility that the genealogical records are to a considerable extent estimates, based upon the physical appearance ("placing") of parents and grandparents or self-placement of the subject themselves, and only to a certain extent family history. This, the author feels, is not possible because of the large amount of overlapping in all the plotted curves of each character in the genealogical classes. Subjects who claimed to be pure negro varied from dark to light, had broad or narrow noses, and so on, even though the average was dark, broad nosed and thick lipped. It seems obvious to the reviewer that the self allocation of a number of subjects who are pale or narrow nosed or thin lipped to the unmixed negro group is evidence that these people at least are not letting certain details of their appearance influence their genealogical statements. But it does not seem possible to infer from this that because they ignore appearance their genealogical statements are necessarily accurate, or to infer that some dark or broad-nosed or thick-lipped subjects have not been influenced by their, or their parents', appearance in putting themselves in the same genealogical class and raising its average. Herskovits' genealogies may be valid but one cannot be certain of this from an examination of the means of the genealogical groups.

Nor, under the circumstances, could the reviewer become impressed with the results of the meticulous analysis of variability in the genealogical classes. For all the traits in the genealogical classes the mean weighted percentage of variability only ranged from .965 in the pure negro group to 1.06 in the negro-Indian, and the pure negro group was not oftenest the least variable nor was the mixed negro-white group oftenest most variable. The author comments in a number of places during this analysis upon the fact that his results are not what would be expected "were low variability and lack of racial mixture as closely correlated as biologists have assumed." No objection can be made to such a statement, but if the author means by it "so much the worse for your biological theories" it would be pertinent to remind him that the biological theories are based upon pedigrees which differ in certain essentials from genealogies.

A measurement of the pigmentation of 174 husbands and wives showed that there had been "a strong tendency toward marriage between dark men and light women." This was not entirely counterbalanced by some tendency toward marriage between light men and dark women, and if, as the author presumes, the lightest men pass into the white race and the darker women do not as often marry, there should be "an increase in negroid features in the future." A transposition of figures (76 for 67) in the average percent of black in the skin color of wives, in table 98, makes these ladies appear, in figure 21, to be nearly all lighter than their computed average. We have in this trivial error an instance of statistical gallantry!

To summarize we may say that the author has made his points concerning the present homogeneity and the homogenetic trend of the American Negro population. The demonstrations of its low variability will surprise many who are more familiar with text book mendelism than critical investigations of racial crosses. Our text books and many papers have imposed upon the layman by greatly overstressing the extent and importance of simple mendelian phenomena, and this the geneticist will have to explain his way out of. The reviewer does not feel that the author's analyses of the genealogical data prove that all subjects actually knew their genetic history and were telling the truth about it, and until these points are settled the data can not serve as a critical test of genetic theories.

R. R. Huestis.

University of Oregon.

Applied Cytology for the Plant Breeder

CHROMOSOMES AND PLANT BREEDING, 105 pp., 1932. By C. D. Darlington. Macmillan & Co. $1.75

THIS book was designed to furnish the practical plant breeder an up-to-the-minute scientific background. The difficulty is that it is too up-to-the-minute, not everything in the book having had sufficient testing nor having been subjected to the criticism of other workers in the same and allied fields. Errors and unproven assumptions too often weaken the force of the very fine parts of this, as well as of some other books on this interesting subject. It is, nevertheless, interesting, stimulating and a valuable addition to books for the "ultimate consumer" of plant genetics.

The statement (P. 8) that "the chromosomes of any kind of plant may be recognized by the constrictions peculiar to them" is probably true providing our microscopes are sufficiently powerful. But practically, many, if not most, chromosomes are too small to make it possible to identify them. Other statements also do not always fit the plant breeder's experience. Thus (P. 63), the influence of a species in crossing is said to be proportionate to

the number of chromosomes sets it contributes. This may be true sometimes or usually but not always, for in crosses between *Fragaria virginiana* (28) and *F. moschata* (21) the characters of the 21-chromosome parent are dominant.

The statement that many of the most important modern improvements in cultivated plants are due to polyploidy (P. 74) might be true if the author is speaking in terms of geological periods, but is hardly true if he is referring to the recent production of polyploids or to improvements due to the variability of polyploids. Cultivated strawberries are polyploids but polyploidy did not arise through cultivation to give us our best garden varieties of strawberries and it is extremely doubtful if this is the case in blackberries (P. 77).

The illustration (P. 79) intended to show a reduction in fertility of seedlings of the Logan, does not appear to bear out the text. In fact, the fruits of all 29 seedlings shown compare well with those of the Logan itself.

The discussion (pp. 97 to 99) of triploid and diploid apples and pears is articularly suggestive to the plant breeder. Here, however, it is possible that English experience differs somewhat from American. The author states that the stronger varieties give regularly weaker seedlings and that seedlings of triploids are all of poor growth, usually distorted and unhealthy looking. In this country the diploid Ben Davis, McIntosh, Red Astrachan, Rome and Twenty Ounce are probably slightly smaller in tree than the triploid Arkansas, Baldwin, Gravenstein, Rhode Island Greening and Tompkins King but the difference is relatively small. Dickson[2] gives a higher seed content for diploids, averaging for Ben Davis, McIntosh and Rome 5.66, 6.60 and 9.73 respectively and for the triploids Arkansas, Baldwin, Gavenstein, Rhode Island Greening and Tompkins King 4.58, 2.06, 3.28, 3.32 and 4.09 respectively. The germination was also less for the triploids, averaging for four of these sorts 18 per cent as compared with 61 per cent for the three diploids. Yerkes[3] gives a larger proportion of large seedlings for the diploid group than for the triploids. However, for Rhode Island Greening he lists 8 per cent of the seedlings as large—larger than 83 per cent of the Ben Davis Seedlings, 92 per cent of the McIntosh seedlings, etc. The author seems to have over-emphasized the difficulties with triploids, at least as far as American sorts are concerned.

The reference to *Fragaria chiloensis* as a species having few-flowered scapes is not borne out by the reviewer's observations.[1] In fact, the largest scapes ever seen by the reviewer have been borne by this species.

These errors in the sections relating to plants familiar to the reviewer suggest caution in accepting all other parts of this modern plant breeder's aid.

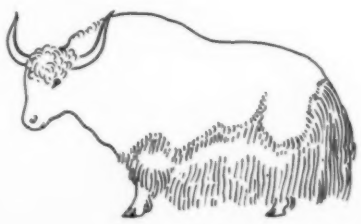
Literature Cited

1. Darrow, G. M. 1929. Inflorescence Types of Strawberry Varieties. *Am. Jour. Bot.* 16:571-585.

2. Dickson, G. H. 1928. Variability of Vigor in Apple Seedlings. *Am. Soc. Hort. Sci.* 165-168.

3. Yerkes, G. E. 1930. Raising Root Stocks from Seed in the United States. *Inter. Hort. Cong.* 9:83-91.

Geo. M. Darrow.



"PRINCIPLES OF GENETICS" REVISED

PRINCIPLES OF GENETICS, A Textbook, with Problems, *by* EDMUND W. SINNOTT, and L. C. DUNN. Second Edition. Pp. xvi + 441. McGraw-Hill Book Co., Inc. 1932.

THIS work has been almost entirely re-written for the present edition, several chapters omitted, and two chapters plus an appendix on "Biometric Methods" (by Donald R. Charles) added. Through enlargement of the type-page, the volume has been maintained at virtually the same size as originally, and yet includes nearly 25 per cent more text. In accord with the authors' decision to restrict the scope of the book to principles only, the three chapters eliminated are those on the application of genetics to plant and animal breeding, and to eugenics.

The first few chapters are apparently not greatly altered, but the chapters on linkage and the chromosome theory of inheritance include a diagram and summary of Stern's neat cytological demonstration of crossing-over, and a discussion of the relation between the cytological and genetic chromosome maps. Balanced lethals, translocations, inversions and deficiencies, induction of mutation (including a description of the C-1-B and "attached X" methods for detecting lethal and visible mutations, respectively) and sex-determination in the lower plants are among the new items discussed in the following chapters.

The two new chapters bear the headings "Genetics and Evolution" and "Genetics and Development"—phrases which are, of course, symptomatic of trends becoming increasingly prominent.

The chapter on "Genetics and Evolution" deals in part with polyploidy and heteroploidy and their probable relation to evolution, and with segmental interchange and ring-formation in Datura and Oenothera. The latter subject is treated at some length; and in part, with the problems of hybridization and inbreeding and (very briefly) with Fisher's theory of the origin of dominance.

The chapter on "Genetics and Development" touches upon the epigenetic character of development, the manifold effects of genes, and the interaction among genes and between genes and environment during development. Effects of genes on the egg and on early development, lethal action, and effects on size and pigmentation are discussed, and numerous examples are given of genes which act as rate-controlling factors.

The thirty page appendix on "Biometric Methods," deals with the usual measures of type and dispersion and the formulae for their determination, and in addition describes the method of curve fitting by the use of a table of areas and ordinates of the normal curve, which is provided. Under measures of reliability, uses of the several standard-error formulae are given, and the interpretation of statistical significance on the basis of these is handled with especail clarity; the x^2 method for testing goodness of fit is also briefly presented.

Obviously, this is a generous array of stimulating material. To the student or general reader who wishes to go beyond the contents of the text, the placing of the bibliographical references (which have been brought well up to date) at the ends of the chapters to which they are appropriate, instead of in a single unclassified list, will be a much appreciated improvement.

The "problems," already excellent and extensive in the first edition, have been revised and added to. The "reference problems" are retained, though it is still not clear precisely for what purpose they are designed, and their value in the present form will doubtless seem to many somewhat questionable.

It is of course unfair to criticise a book of this size, already remarkably comprehensive despite its compactness, on the grounds of specific omissions. The present reviewer feels, however,

that the chapter on the determination of sex is hardly complete without some discussion of sex determination in parthenogenetic forms; and that the chapter on Genetics and Evolution might include at least the derivation of the basic formula showing the stability of a mendelian population under conditions of random mating, with perhaps an indication of how this would be affected by various systems of mating, and, possibly, by different types, if not different degrees, of selection.

P. R. DAVID.

Storrs Agricultural Experiment Station.

How We Grow

GROWTH AND DEVELOPMENT OF THE CHILD. Part IV. Appraisement of the Child. The Century Co., New York, 1932, pp. xix + 344.

THIS volume on *Appraisement of the Child* is the fourth of a series of volumes on the *Growth and Development of the Child* issued under the auspices of the White House Conference on Child Health and Protection. The authorship of the volume cannot be attributed to any one in particular. As explained in the general introduction, "After each topic had been drawn up in tentative form the Committee met together for free discussion and criticism of the facts and opinions presented by each member. When each section had been written in the light of this discussion it was then sent to other members of the Committee for further criticism, so that the ultimate publication is, so far as it is possible to make it, a Committee report representing the consensus of expert opinion."

The volume consists of a résumé of the results of recent investigations on the development of children both mentally and physically. There is a survey of the results of intelligence tests on all sorts of children from mental defectives to embryo Newtons and Shakespeares, a discussion of the findings on the constancy of the intelligence quotients, a résumé of work on special aptitudes and the development of mentality in the pre-school years. Three sections are devoted to the development of motor skills in different ages from infancy to adolescence. There is a discussion of the relation of the intelligence of children to home environment and the occupations of parents. Personality tests form the subject matter of one section, and several sections are devoted to physical growth and development and their relation to mental development and personality.

The book is a mine of information on these and other related topics which are of special interest both to the student of child development and to eugenists. What makes the volume of especial value as a book of reference are the numerous bibliographies at the close of the sections.

In reading this volume one is forcibly impressed with the vast amount of research on child development which has been carried on in recent years, the numerous subjects attacked, and the need for further investigations in many lines. Another fact that impresses one is the number of topics on which we really know almost nothing. The amount of research required to clear up the uncertainties, to resolve the contradictory findings and to fill in the gaps in our knowledge in this field is appalling. There is need for an army of researchers and millions of money. Much of the money will of course be wasted, but, on the whole, it will be a paying investment because of the transcendant importance of knowledge of the various influences which affect the physical, mental, and moral development of the child. The whole subject of child development is in an embryonic stage. This and other volumes of the series represent the results of taking stock of recent progress. For this reason they will be of much value to investigators and to students of education and the social sciences.

S. J. HOLMES.

University of California.

ABNORMAL "ABNORMAL PSYCHOLOGY"

FOUNDATIONS OF ABNORMAL PSYCHOLOGY, *by* FRED A. MOSS and THELMA HUNT. Pp. 548. 21 Chapters. 3 Plates. Price, $4.50. New York, Preitice-Hall, Inc., 1932.

WITH the purpose of presenting an objective scientific evaluation of the present status of abnormal psychology; the authors, in the preparation of their book "have relied very largely" upon the contributions of chemistry, bacteriology, pathology, endocrinology and neurology for their "basic materials"—"The book is written from the point of view that places psychology in the group of the natural sciences, leaving out the metaphysical and speculative materials." It is definitely stated that the only scientific approach to mental disorders is the observation and study of the physical agents such as chemical changes, toxins, tumors, central nervous system lesions, etc. (causing the disturbance), and of the tissue pathology. With this attitude as a nucleus the reader should not be surprised to find the subject matter treated from a limited point of view, and totally lacking in a recognition of those dynamic principles of Adolf Meyer, Sigmund Freud, E. Kretschmer and others, all of which take carefully into consideration the physical constitutional aspects, and which have contributed so much to the understanding of abnormal human behavior. One is disappointed in not finding references to the foreign literature, other than a few to English works, as there are numerous researches that could have been consulted and included with profit, lending considerable additional support to the physico-chemical concepts of mental disorder.

If one is so minded, it is entirely possible, but difficult if one wishes to be comprehensive, to write an "abnormal psychology" without including a description or a discussion of psychoanalytic principles, but the authors have seen fit to make critical comments taken chiefly from secondhand prejudicial sources, and without showing any evidence that they have read, much less understood, Freud's original contributions. This unscientilc attitude in the midst of so much strong advice on scientific methods is rather startling. Among the numerous misleading statements regarding the psychoanalytic doctrines, the following appears on page 225: "It is difficult to understand why the Freudian theories have been so widely accepted in America, and have gained practically no hold in England." As a matter of fact, England is the home of some of the most active psychoanalytic endeavors, of such outstanding contributors as Jones, the Glovers, Flugel, Rickman, Tansley, Bryan and Melaine Klein, and of the "International Journal of Psychonanlysis."

The title of the book overstates its scope as one searches in vain for abnormal psychology, as such. In the chapter on causes of mental disorders, the "emotional causes" are barely mentioned, and then only to be discarded. There is a failure to recognize that modern psychopathology covers a much more extensive field than its name would imply, for the study of the abnormal aids in revealing the normal. No one with experience will deny that physicial conditions such as toxaemias, syphilis, brain tumors, senility and a host of others may and do release mental disorders, but the fact remains that any one of them may cause almost any variety of mental disorder. General paresis, a disorder with a definite organismal etiology, may release any one of a variety of mental syndromes, e.g., depression, dementia precox syndromes, manic elation, the presbyophrenic complex, or just simple deterioration. In other words, the physical disease releases something more fundamental as far as the psychosis is concerned. (The same may be said of the effect of alcohol.) There is little gained by speculative attempts at "chemicalizing" or "neurologizing" psychol-

ogy. There is little doubt that chemical and physical changes do occur with every change or thought or mood, but until we know more about them, we must describe the mind and its disorders in psychological terms and concepts, as any physical or chemical change in a complex biological situation may be either cause or effect.

There is little reason for calling the student of "functional" disorders "unscientific" or of accusing the psychotherapist of "mystic" relationships when he refuses to pursue his patients with a hypodermic syringe, a surgeon's knife, or a dose of bitters, when the real problem is a distorted life relationship having its origin largely in early parental and societal contact, or in present acute interpersonal difficulties. It goes without saying that anemias, obvious surgical conditions, toxaemias (if they are real and not just assumed) and sick livers should be treated and corrected wherever they are found. But where is the evidence that they *cause* mental disorders? When we are tempted to accuse others of being unscientific in their methods and conclusions, as the authors have done, it would be well to keep in mind the following statement by Dampier-Whetman (1930): "One phenomenon may be regarded in different ways—a stick to the school-boy is a long elastic rod; to the botanist it is a bundle of fibres and cell walls; to the chemist a collection of complex molecules, to the physicist a swarm of electrons. A nerve impulse may be considered in a physical, a physiological or a psychological aspect and none is more real than another."

All in all the book is a curious mixture of poetical quotations and personal opinions mixed with experimental and observational facts, and it is prophesied that any open-minded student who becomes soaked with this particular aspect of psychopathology is in line for a surprise when he later tackles the real problems with which he will be presented by his patients, but he will survive if he has the knack of observation and of seeing clearly the fundamental distinctions, and moreover he can still be "scientific."

N. D. C. Lewis.

Saint Elizabeth's Hospital.

The "Sterilization Spectre"

BEHIND THE DOOR OF DELUSION. *By* "Inmate Ward 8." Pp. xvi + 325. The Macmillan Company, N. Y. 1932.

TO readers of the Journal of Heredity the chief interest in this on the whole rather interesting book is the chapter headed "The Sterilization Spectre," which affords an impression of eugenical sterilization from an altogether unusual angle, viz., from the viewpoint of those to whom it is likely to be applied. The author, who is a former newspaper editor, and apparently not insane in the usual acceptation of the word, but incarcerated with his own consent in a last-resort effort to be cured of dipsomania, touches upon the hysterical desperation wrought among the inmates of the asylum by the news that the legislature has passed a sterilization act, and proceeds to his own reactions to the law which, representing as they do the viewpoint of an intelligent and better-than-average informed layman, are perhaps of some significance.

The particular measure he is discussing provides that those about to be released from an asylum may be sterilized at the discretion of the superintendent if they are "afflicted with hereditary forms of insanity which are recurrent—idiocy, imbecility, feeble-mindedness or epilepsy." (Reference to Landman's "Human Sterilization" makes it evident that it is the Oklahoma statute of 1931 which is re-

ferred to.) His pointing out the pathetic inadequacies of the intended "legal safeguards" to the patient has specific reference to this statute (though, of course, it might equally well apply to a number of others), but his other strictures are more general: He contends, in brief, first, that a program of compulsory sterilization in mental cases of diverse sorts, where expert opinion is divided on the question of the type of heredity, if any, which is involved, is premature; and, second, that even if on the basis of a definitely ascertained recessive genetic etiology it is valid to sterilize defectives of a given type, by logical extension one should accord the same treatment to parents and collaterals of the defectives, and decision as to where to stop would be impossible. Neither of these objections is new, of course, and in each there is much justice. In fact, as is well known, where the incidence of a recessive defect in the general population is low to begin with (of the order of 1/10th of one per cent), even sterilization of *all* affected individuals in every generation reduces the incidence at a very slow rate, so that the eugenic value of the procedure may be questionable.

What "Inmate Ward 8" overlooks, and what, indeed, seems to be overlooked by a good many of the strongest advocates, as well as opponents, of these measures, is that their justification at the present time can hardly be based on eugenic grounds primarily, but, if it is to be found at all, must be sought elsewhere. For example: wholly aside from what germ-plasm the feeble-minded or recovered insane may or may not transmit to their offspring, there is the question as to whether these classes are fitted to discharge the rather intricate responsibilities of parenthood,—a function in which, it must be confessed, many of our most favorably endowed not infrequently appear to fall down.

For the rest of the volume, the author is to be congratulated mainly for the sobriety and absence of sensationalism in his account. Incidental points of interest which emerge concern: social stratification among the inmates (entirely independent, of course, of status in the outer world); the primevality of the female insane; the general fear of religious fanatics, who are customarily the most dangerously violent of patients; and similar items which, on the whole, give the impression that life in Ward 8 is not vastly different from that in the world without.

PAUL R. DAVID.

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Heredity and Mental Hygiene

WHEN the First International Congress of Mental Hygiene convened in Washington in 1930 the writer was both enlightened and edified by the recognition accorded human genetics at that gathering. A third of a morning of one section of the Congress was devoted to the subject "Heredity and Mental Hygiene." This was sandwiched in between symposia on "Alcoholism and Mental Hygiene" and "Syphillis and Mental Hygiene." If a man is known by the company he chooses, may it not be equally true that one may appraise the state of a movement by the company in which it brackets subject matter for discussion?

This lone session on human heredity was most interesting. Ernest Rüdin, of Germany, and C. B. Davenport of America, went gallantly over the top for a genetic basis of mental disease. They were met by a barrage of verbal brickbats and emotional smoke screens, which in the time

available, left matters in a very unsatisfactory state. With only a few minutes to go, a gentleman, whose name is not known to the writer, got the floor and made rather a touchdown for human genetics. He said that he was the superintendent of an institution for mental defectives. He had listened with great interest to the discussion, and had a proposition to make: He had in his charge a large number of feebleminded children from families that gave a convincing history of feeblemindedness. He would be glad to accommodate all those present who had spoken so enthusiastically about intangible psychological and environmental factors, and to furnish one or more subjects to be brought up any way these persons chose to correct the heredity of these unfortunates. The speaker went on to say that after what he had heard he was half led to believe that this should not be difficult. He would be glad to accept bids for any such experimental material on the spot. After waiting a decent interval for acceptance of this generous offer (of which there were none) the speaker sat down and the meeting was adjourned.

The world does move, especially in depressions, and the current (January 1933) issue of *Mental Hygiene*, the quarterly publication of the National Committee for Mental Hygiene, contains considerable evidence that it has moved in the field of mental hygiene. Several of the articles present in milder form the conventional point of view of three years ago: "In spite of the fact that parents often succumb to the temptation of explaining obnoxious traits in their offspring by blaming them on the remote ancestry, it is nevertheless true that inheritance is far from being the sole determining factor in personality building. There is little doubt that in the past the influence of heredity has been overstated, and [what a comedown after so sweeping a beginning!] there is little doubt too that inherited traits are capable of a little measure of modification." This is the high point of the environmental view, and closing as it does it is not so very high.

Even so non-committal a view is hardly sustained by several other articles in the same issue. One reports a study of the children of schizophrenic patients. This study ("undertaken without any preconceived notion of what it might reveal"), shows that 30% of the offspring of such parents have encountered difficulties of both a mental and a social nature. Over half (60%) of the schizophrenic patients have had maladjusted children. In these 38 families 64% of the children have been somehow or other abnormal. The case histories given in this article are excellent material for the human geneticist. Part of the children, *but not all of them,* even though all were exposed to a neurotic environment, exhibit abnormal traits. The picture is one of segregation of mental characteristics as definite as segregation in hair or eye color.

The Limiting Factor

Another article deals with an account of a rather remarkable foster home. Here we have excellent examples of the interaction of heredity and environment. All of the children at this foster home were sent there to get them away from utterly impossible and hopeless home conditions. All of the children while there underwent a distinct metamorphosis. This may sound bad for the advocates of heredity, but such is by no means the case: "Harvey is a depressing example of the fact that individuals have definite limits of improvement, and that 'we cannot make a silk purse out of a sow's ear.' * * * * One cannot deny that the home has greatly helped Harvey. It has, however, been unable to fit him to meet the world because the boy's innate capacity is not sufficient." * * * * "Donald's history shows even more limited improvement. * * * *If we could fully explain why Donald has failed to adjust, while the other

boys have successfully adjusted, we should have the solution of much of the mystery of human nature." The student of human genetics could ask hardly more than this in the way of confirmation of his views. The individual is, of course, the product of the interaction between a given environment and a given gene-complex. Change the environment, and the resultant is altered, true, but the end product is not the same as that resulting from a different gene-complex,—one capable, in a good environment, of producing a "normal" or a "superior" individual.

There is even more. In an article on the "Rôle of Art in Personality Development" we come across this interesting observation: "One such youngster sat through class hour after class hour in which other children were writing poetry, planning pageants, drawing and painting, deciding on color schemes for their spring play. This boy had no suggestions to make, and was lost as far as that group was concerned. The teacher followed the boy and his class about, and watched his behavior in mathematics classes, sciences classes, and in shop. She discovered after awhile that his major interest was electricity. Electricity has an art value." So the boy was saved for the art class, not by making a Michaelangelo of him, but by appointing him stage electrician. Since this Mohamet could not go to the mountain of art, the mountain of art was brought to Mohamet, which is as it should be, and after all must be, even though heredity be classed by mental hygienists with the diseases.

One might go on; for the examples from this issue from the official mouthpiece of Mental Hygiene are not exhausted. The change may have been so slow as not to have been noted by the prophets and apostles of the movement. Be that as it may, one can dare to hope that if and when the Second International Congress of Mental Hygiene is held the inheritance of mental deficiency and efficiency will bulk larger than in 1930. That, after all, is as much as we could expect, and more than we could have dared to hope a few years ago. Perhaps when the smoke clears away it will be seen that depressions have their victories no less than booms, and wars, and other "acts of God." Out of the depression is undoubtedly growing a considerably increased interest in the subject of human heredity.

R. C.

Iltis' *Mendel* Translated

THE LIFE OF MENDEL, by Hugo Iltis, translated by Eden and Cedar Paul. $5.00. W. W. Norton & Co., Inc., New York, 1932.

TIME deals with Mendel with slow deliberation. His great work of the eighteen-sixties comes first to scientific recognition forty years later, and reaches the general public a hundred years after his birth; the biography of the man who died in 1884 appears in his mother tongue in 1924, and then eight years pass before it is rendered into English; finally as if to preserve the established tempo, the translation comes to review many months after its publication.

This unhurried appreciation reflects both the secureness of his reputation which needs no insistent clamor to sustain it, the quietness of his own life and scientific work, and the paucity of

information from which a dramatic and appealing legend might be erected. The *Leben, Werk und Wirkung* by his devoted biographer Hugo Iltis of Brünn records the little that is known of Mendel in the sober and careful manner befitting the subject, and the English version is a faithful rendering of that portion of the German text which relates to the events of Mendel's life and work. The last half of Iltis' book which dealt with the development of genetics after 1900 is not included in the translation and the omission seems justified by the existence of better accounts of modern genetics and by the rapid changes in the subject since Iltis' review was published in 1924.

There remains a volume of some three hundred pages of which possibly half consists of strictly biographical material relating to Mendel's ancestry, to the external details of his uneventful life of sixty-two years (of which nearly forty were spent in the monastery at Brünn) to his education, his experiences as a teacher, his relations with his fellow priests and scientists, and his career as administrative head of the monastery. The remainder of the volume consists of an exposition of the results of his studies of hybridization with peas and hawkweed, of meteorology, bee-breeding and horticulture. It is from these accounts of his scientific work that the character of the man appears rather than from the letters, autobiographical notes, memoirs and testimony of contemporaries which for most persons of recognized eminence form the raw material for biography, but which in Mendel's case are almost non-existant.

Those who are not familiar with Iltis' book will find in this translation a new and surprising appreciation of one of the significant figures in the history of biology. The figure which emerges is not the "obscure priest" of biological legend who in a brief flash of scientific genius created a new conception, but a man of breadth and competence in many fields of science.

The publishers are to be congratulated for undertaking in these times the issuance of a work of permanent value which can expect, at present, only a limited audience. It is unfortunate that the number of readers should be still further limited to those who can pay five dollars for a book which as far as manufacturing goes resembles other good books selling at half that price.

L. C. Dunn.
Columbia University.

Black and White in Africa

Cipriani, Lidio. Considerazioni sopra il Passato e l'Avvenire delle Popolazioni Africane. Florence, 1932. Pp. 166.

THE importance of the Negro problem in the United States gives particular interest to this study of the Negro in Africa, which is published as Vol. 3, 2d series, of the Italian Committee for the Study of Population Problems. It is a joint publication with the Italian Society for Genetics and Eugenics. Professor Cipriani discusses at length the inferiority of the Negro race and the impossibility that it will develop the Dark Continent on its own account. If the task can be done only by the white race it is, he thinks, only the Italians among the various representatives of the white race, that have the surplus of population to carry it out. He therefore regards Africa as inevitably subject to the future domination of Italians, not merely commercially but by actual colonization. An increase in the proportion of white blood among the Negroes, by hybridization, is regarded as an inevitable and probably also a desirable result.

Paul Popenoe.

LETTERS TO THE EDITOR

Springs of Life

I JUST want to say a few words to thank you for that elaborate review of my book *Can Science Explain Life?* which you published about half a year ago. Whether the review was favorable or unfavorable is only a matter of secondary importance, the main object being to bring it to the attention of the public.

There are just two matters that I should like to mention as a sufficient answer to Dr. Muller:

First. The spirazine structure is no longer a mere theory or hypothesis, but a proven fact. Almost immediately after my first announcement of the spirazine theory in 1926, X-ray diffraction photographs of protoplasmic materials were taken and it was found that they had a helical chemical configuration, exactly as I had predicted. (See J. Alexander's *Colloidal Chemistry*, 1931, Vol. 3, pp. 37 and 38.) Consequently anyone who attempts to dispute the spirazine theory today will also have to dispute the experimental findings of competent physicists. Polypeptides and asymmetric chemical structures had been known for over half a century, but prior to the first announcement of my theory there had been no suggestion in scientific literature that polypeptides have a helical chemical configuration in living matter.

Second. At the last annual meeting of the British Association for the Advancement of Science, held at York, England, in September, 1932, the idea that the chemical structure of living matter must be spiral (i. e., helical), was discussed with such emphasis that the reports of it even found their way into the newspapers of this country. Now, if there is nothing of biological significance in the spirazine idea, then why did those British scientists give it so much attention at their last meeting?

C. F. KRAFFT.

2510 Q St., N. W., Washington, D. C.

Shoulderblades—"Stigma" or "Index"—?

ON page 317 of the August *Journal of Heredity* you quote Dr. Graves' article on scapulae which appeared in the *Eugenics Review* (Oct., 1931), and append the following footnote:

"One questions the wisdom of the covertitle under which this article appears: *Stigmata of Degeneracy*. With a correlation considerably less than 1, normal people (even the highly gifted) who bear such a "stigma" are not likely to have their enthusiasm for eugenics increased by such a misleading, almost insulting, misuse of terms, not in any way implied in the text of the article."

In giving that footnote you omitted to refer to Dr. Graves' own courteous letter to the same effect in the next number of the *Review*, or to the editorial note which followed it and explained that the term "stigmata" is as frequently used in a complimentary as an "insulting" sense—see any authoritative English dictionary. The title employed by the *Review* would be no more likely to be misunderstood in this country than would your own "An Index to Fitness."

The *Journal* and the *Review* are engaged on the same work in different spheres, and it is most desirable that they should be on the friendliest possible terms; so I hope you will pardon my pointing out that "stigmata" is only one of many words in our common language which bear somewhat different connotations in America and England, and that caution should therefore be exercised before making an apparent verbal infelicity the occasion for printed comment.

ELDEN MOORE,
Editor, *Eugenics Review*.

(*Continued on page* 126)

Just after writing this letter I have received your September number, containing Dr. Morris' letter on the same subject. Evidently, the word "stigmata" is frequently used in America, as well as in England, in the same way as in our cover title.

While you add a comment to Dr. Norris's letter, and refer therein to Dr. Grave's in the subsequent number of the *Review*, you still ignore our editorial note.

I should like to discuss the interesting points raised by Dr. Morris; but consideration for your space makes me refrain.

E. M.

The editor of the JOURNAL OF HEREDITY regrets if anything written by him should prove embarrassing to the *Eugenics Review*, a publication for which he has the highest regard. Nevertheless he still feels that the concatenation of the words "stigmata" and "degeneracy" is likely to produce unfortunate reactions on either side of the Atlantic—more perhaps because of the connotations of "degeneracy" than of "stigmata." However that may be, Mr. Moore's note on the fact that words do differ in meaning in England and America is greatly appreciated. In the future any comments on articles of British origin shall, on the principle of "safety first," be checked against "Murray's Oxford."

R. C.

Why Social Invention Lags

I AM recorded as inventor on more than fifty patents, have made a hundred or two other inventions not patented, have designed more than a hundred new and complex automatic machines, and have done a few other things.

As engineer, inventor and attorney for other inventors. I have some realization of what has occurred, and the reasons for it. The reason why mechanics moves so fast and other sciences so slowly is that mechanics encourages the inventive mind, and all other sciences discourage it.

The Patent Office is the only place in the world where anyone can take something new in science and have it considered on its merits, and the Patent Office is limited to a consideration of certain things mentioned in the statute. I have a number of inventions in various sciences, and I know other persons with other inventions, but it is useless to attempt to do anything with them.

If I go to a manufacturer and tell him that I have an invention related to his business, and one which has been considered by the Patent Office, he is all attention and will spend time and money to find out if he can use it. If I go to a university and tell them that I have worked out an invention related to some science they are teaching, I get ——, well, not exactly what I would get from a manufacturer approached in the same way.

Newton's law of gravitation was an invention, and his own university would not accept it until twenty years after he had told the story to the Royal Society. Twenty years went by before anyone would pay attention to the Periodic table of Mendeléeff, and so on. If a country boy from Kansas comes along with something comparable to the law of gravitation, he gets no consideration, but a country boy from Kansas made the modern automatic telephone exchange, which is less difficult mathematically than the law of gravitation, but more difficult in other ways.

The Darwinian theory and the Mendelian theory are inventions. They have those characteristics which distinguish invention from the work of an ordinary mechanic, or that of a clerk. How many things exhibiting similar originality have appeared in the biological sciences during the past year? Inventions in the mechanic arts and sciences come along at the rate of more than a thousand a week. Other sciences are not more difficult. They have gone to sleep.

CASPER L. REDFIELD.
Solicitor of Patents, Chicago, Ill.

A Glossary Of Genetic Terms

AGGLUTINOGEN—A substance from which an agglutinin is produced; which, in turn, is a substance which has the property of clumping and precipitating certain specific types of blood corpuscles or bacteria.

ALLELOMORPH—Mendelian characters are inherited in alternative pairs, or in alternative series. These alternative genes are called allelomorphs. Examples: Albinism (recessive), Normal pigmentation (dominant); Horns (recessive), Hornlessness (dominant).

BACK-CROSS—Cross of a hybrid to one of the parental forms.

CHIASMA—"In the diptolene stage (of cell division) the chromatids are associated in pairs in such a way that in one part of their length two chromatids are associated but in another part each is associated with a different chromatid. The point of exchange is termed a chiasma." (Sansome and Phipp, 1932.)

"Exchange of partners between the four chromatids of a bivalent." (L. H. Hill, 1932.)

CHROMATID—Chromosomes frequently bear the foreshadowing of a future longitudinal division so that they appear to be made up of two parallel threads. These threads are the chromatids.

CHROMOSOMES—Tiny dark-staining bodies visible in the nucleus of the cell at the time of cell-division. The number of chromosomes in any species is usually constant. The chromosomes carry the genes, linearly arranged, which control the development of Mendelian characters.

CROSSING OVER—Interchange of segments between two homologous chromosomes previous to the formation of gametes.

CONJUGATION—Side-by-side association of homologous chromosomes previous to formation of gametes.

DIPLOID—Having two sets of chromosomes. Body-tissues of higher plants and animals are ordinarily diploid in chromosome constitution. See *Somatic*.

DOMINANT—A character possessed by one of the parents of a hybrid, which appears in the hybrid to the exclusion of the contrasted character from the other parent (the recessive). Thus in a cross of green- and yellow-seeded peas the first generation has yellow seeds. Yellow is dominant and green is recessive, being transmitted but not appearing in the presence of the factor for yellow.

FACTOR—Same as *Gene*.

F_1—(Pronounced eff-one). The first filial generation. The offspring of a given mating.

F_2—The second filial generation. Produced by intercrossing or self-fertilizing the F_1. The inbred grandchildren of a given mating.

GAMETE—A reproductive cell of either sex; e. g. sperm or ovum.

GENE—(1) The unit of inheritance, which is transmitted in the germ cells, and which by interaction with the genic and cytoplasmic complex controls the development of a character. The genes are arranged linearly in the chromosomes. (2) "The physical basis of heredity"—or more figuratively, the atom of the genetic molecule.

HAPLOID—Having the reduced number of chromosomes, as in germ cells, as distinguished from the diploid or double number of chromosomes in normal somatic cells.

HETEROZYGOUS—Containing both genes of an allelomorphic pair, or two genes of an allelomorphic series. Heterozygous individuals generally resemble the individuals homozygous for the dominant character, but they transmit the recessive to half their offspring.

HOMOZYGOUS—(1) An organism formed by like germ cells; (2) An organism is said to be homozygous for a given character when all the germ cells transmit identical genes for this character. This is the most frequently used meaning of the term.

LINKAGE—Association of genes in inheritance, due to the fact that they are in the same chromosome.

MUTATION—A sudden variation in an inherited character.

ONTOGENY—The developmental history of an organism, from fertilized egg to adult individual

RECESSIVE—See *Dominant*.

SOMATIC—Referring to body tissues; having two sets of chromosomes, one set normally coming from the female parent and one from the male; as contrasted with germ cells having a single set of chromosomes.

SEGREGATION—Separation of allelomorphic genes at meiosis.

SELFED—Self-pollinated.

TRANSLOCATION—Attachment of a fragment of one chromosome to a non-homologous chromosome, resulting in a new arrangement of genes.

ZYGOTE—An organism produced by the union of two germ cells.

A-G-A

G-e-n-e-t-i-c-s

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